Chapter 3
Science and Engineering Workforce

Highlights

- **The U.S. workforce in 1999 included 11 million college-educated individuals with either science and engineering (S&E) degrees or S&E occupations.** The vast majority (10.5 million) held at least one college degree in a science or engineering field. About 31 percent (3.3 million) of the 10.5 million S&E degree-holders in the workforce were also employed in S&E occupations. Regardless of occupation, more than three-quarters of those whose highest degree was in S&E said their work was related to their degree.
- **Since 1980, nonacademic S&E jobs grew at more than four times the rate of the U.S. labor force as a whole.** Nonacademic S&E jobs increased by 159 percent between 1980 and 2000—an average annual growth rate of 4.9 percent compared with 1.1 percent for the entire labor force.
- **The total number of retirements among S&E-degreed workers will increase dramatically over the next 20 years, barring large changes in retirement rates.** More than half of S&E-degreed workers are age 40 or older, and the 40–44 age group is nearly four times as large as the 60–64 age group.
- **Despite increasing retirements, the S&E labor force is likely to increase for some time, albeit at a slower rate.** The rate of S&E-degreed workers reaching retirement ages will remain less than the rate of S&E degree production for many years.
- **Labor market conditions for those with S&E degrees improved during the 1990s.** Holders of S&E bachelor's degrees had lower unemployment rates and were significantly more likely to be doing work related to their degree in 1999 compared with 1993.
- **Labor market conditions for new Ph.D. recipients have been good by most conventional measures.** S&E doctorate-holders are both employed and doing work relevant to their training. Employment gains have come in the nonacademic sectors. In most fields, a small percentage of recent Ph.D. recipients are obtaining tenure-track positions.
- **In April 1999, 27.0 percent of doctorate-holders in S&E in the U.S. labor force were foreign born.** The lowest percentage of foreign-born doctorate-holders was in psychology (7.6 percent), and the highest was in civil engineering (51.5 percent). About one-fifth (19.9 percent) of those with master's degrees in S&E and about one-tenth (9.9 percent) of those with bachelor's degrees in S&E were foreign born. The largest percentages of these degrees were in electrical engineering (18.3 percent), civil engineering (16.1 percent), and computer sciences (15.2 percent).
- **High-skill temporary-visa migration is becoming an important factor in many economies.** In 1999, 240,936 workers entered Japan in high-skill visa categories—a 75 percent increase since 1992. Germany has recently introduced a high-skill temporary visa program.
- **The Bureau of Labor Statistics forecasts faster growth in S&E occupations than in any others.** From 2000 to 2010, S&E occupations are projected to increase by 47 percent compared with 15 percent for all occupations. Although a projected 82 percent increase in computer-related S&E occupations will almost certainly dominate this expansion, most major S&E occupational groups are projected to show above-average growth.

Introduction

Chapter Overview

Within the U.S. civilian workforce, a group generically referred to as "scientists and engineers" consists of people educated in science (including life, physical, social, computer, and mathematical sciences) and engineering (S&E) and people who, although not educated in these fields, hold S&E occupations. This varied workforce includes technicians and technologists, researchers, educators, and managers of the S&E enterprise. Although these workers make up only a small fraction (less than 5 percent) of the total U.S. civilian workforce, their effect on society belies their number—scientists and engineers contribute enormously to technological innovation and economic growth, scientific and engineering research, and a greater understanding of S&E.

Chapter Organization

This chapter first presents a profile of the U.S. S&E workforce, including workforce size and various employment characteristics. Information on the sex and racial or ethnic composition of the S&E workforce is provided, followed by a description of labor market conditions for recent bachelor's, master's, and doctoral S&E degree recipients. Discussions on the effects of age and retirement on the S&E workforce and the projected demand for S&E workers over 2000–10 are presented. The chapter concludes by examining the global S&E workforce and the migration of scientists and engineers to the United States.

Profile of the U.S. S&E Workforce

Data in this section are from the National Science Foundation's (NSF's) Scientists and Engineers Statistical Data System (SESTAT), which is a unified database containing information on the employment, education, and demographic characteristics of scientists and engineers in the United States.[1]

How Large Is the U.S. S&E Workforce?

Estimates of the size of the U.S. S&E workforce vary based on the criteria used to define a scientist or engineer. See sidebar, "Who Is a Scientist or Engineer?" Education, occupation, field of degree, and field of employment are all factors that may be considered.[2] For example, should any employee with an S&E education be considered a member of the S&E workforce, or should only someone employed in an S&E occupation be considered? In 1999, more than 13 million people in the United States either had an S&E education or were working as scientists or engineers. (See appendix table 3-2.) The number of college-degreed individuals in S&E fields in 1999 exceeded the number of individuals working in S&E occupations because many S&E degree-holders were not working in S&E fields. Also, many individuals who held S&E occupations were educated in fields not considered science or engineering.

Basic Characteristics

Including those either trained or working as scientists or engineers, approximately 13 million[3] scientists and engineers were residing in the United States as of April 1999. However, only 84 percent (nearly 11 million) of these individuals were in the workforce. (See text table 3-1.) The remaining individuals were either unemployed but seeking work (193,200) or not in the workforce (1.86 million).

Of the nearly 11 million individuals trained or working as scientists and engineers in the United States in 1999, the vast majority (almost 10.5 million) had at least one college degree in an S&E field. About 30 percent (3.3 million) of the almost 10.5 million S&E degree-holders in the workforce were also employed in S&E occupations. The remaining one-half million individuals had college degrees in non-S&E fields but were currently or had been previously employed in S&E occupations. See sidebar, "Growth of the S&E Workforce."

What Do People Do With an S&E Education?

Many U.S. scientists and engineers have multiple S&E degrees or have degrees in both S&E and non-S&E fields. Many S&E-educated workers also routinely find S&E-related employment in occupations not included within traditional S&E classifications. In 1999, of the 10.5 million S&E degree-holders in the workforce, about three-fourths (almost 8 million) reported that their highest degrees were in S&E fields. (See text table 3-1.) However, many of these individuals (approximately 5 million) were not employed principally in a science or engineering occupation.

Although the majority of S&E degree-holders do not work in S&E occupations, their S&E training does not necessarily go to waste. Of the 5 million S&E degree-holders perform-

[1]SESTAT data are collected from three component surveys sponsored by NSF (*National Survey of College Graduates, National Survey of Recent College Graduates,* and *Survey of Doctorate Recipients*) and conducted periodically throughout each decade. SESTAT's target population is U.S. residents who hold bachelor's degrees or higher (in either an S&E or a non-S&E field) who, as of the study's reference period, were noninstitutionalized, not older than age 75, and either trained or working as a scientist or engineer (e.g., either had at least one bachelor's degree or higher in an S&E field or had a bachelor's degree or higher in a non-S&E field and worked in an S&E occupation during the reference week. For the 1999 SESTAT, the reference period was the week of April 15, 1999.

[2]For a detailed discussion of the S&E degree fields and occupations in SESTAT, see NSF 1999a. A list of S&E occupations and fields is contained in appendix table 3-1. In general, S&E occupations and fields in this report include those in the field of social sciences and exclude medical practitioners and technicians (including computer programmers). Thus, a physician with an M.D. will not be considered to be "S&E" either by occupation or by highest degree, but he is likely (but not certainly) to be included in statistics that incorporate those with S&E degrees based on their field of bachelor's degree.

[3]This number includes all those who received a bachelor's degree or higher in an S&E field plus those holding a non-S&E bachelor's degree or higher who were employed in an S&E occupation during either the 1993, 1995, 1997, or 1999 SESTAT surveys.

Who Is a Scientist or Engineer?

The terms “scientist” and “engineer” have many definitions—none of which are perfect. For a more thorough discussion of these complexities, see *SESTAT and NIOEM: Two Federal Databases Provide Complementary Information on the Science and Technology Labor Force* (NSF 1999e) and “Counting the S&E Workforce—It’s Not That Easy” (NSF 1999b). Multiple definitions are used for analytic purposes in this report, and even more are used in reports elsewhere. Three main definitions used in this report are as follows:

- ♦ **Occupation.** The most common way to count scientists and engineers in the workforce is to include those having an occupational classification that matches some list of science and engineering (S&E) occupations. Although considerable questions can arise regarding how well individual write-ins or employer classifications are coded, the occupation classification comes closest to defining the work a person performs. An engineer, by occupation, may or may not have an engineering degree, but correct classification will show that worker as doing engineering work. One limitation of classifying by occupation is that it will not capture individuals using S&E knowledge, sometimes extensively, under occupational titles such as manager, salesman, or writer.* It is common for a person with a science or engineering degree in such occupations to report that his or her work is closely related to his degree and, in many cases, also report research and development (R&D) as a major work activity.

- ♦ **Highest degree.** Another way to classify scientists and engineers is to focus on the field of their highest (or most recent) degree. For example, classifying as “chemist” a person who has a bachelor’s degree in chemistry but works as a technical writer for a professional chemists’ society magazine—may be appropriate. Using this “highest degree earned” classification does not solve all problems, however. For example, should a person with a bachelor’s degree in biology and a master’s degree in engineering be included among biologists or engineers? Should a person with a bachelor’s degree in political science be counted among social scientists if he also has a law degree? Classifying by highest degree earned in situations similar to the above examples may be appropriate, but one may be uncomfortable excluding an individual who has a bachelor’s degree in engineering and also a master’s degree in business administration from an S&E workforce analysis.

- ♦ **Anyone with an S&E degree or occupation.** Another approach is to classify by both occupation and education. National Science Foundation sample surveys of scientists and engineers attempt to include those residing in the United States who have either a science or an engineering degree or occupation.†

*In most collections of occupation data, a generic classification of postsecondary teacher fails to properly classify many university professors who would otherwise be included by most definitions of the S&E workforce. Scientists and Engineers Statistical Data System (SESTAT) data mostly avoids this problem.

†Individuals who lacked a U.S. S&E degree but who earned an S&E degree from another country are included in 1999 SESTAT data to the extent they were in the United States in 1990, 1993, 1995, 1997, and 1999, as were those who had at least a bachelor’s degree in some field and who were working in an S&E occupation in 1993, 1995, 1997, and 1999.

ing non-S&E jobs in 1999, 67.3 percent indicated that they were employed in a field at least somewhat related to the field of their highest S&E degrees.[4] (See text table 3-2.) Almost 80 percent of those whose highest earned degrees were in mathematics or computer sciences and who were employed in non-S&E jobs were working in fields related to their degrees compared with 63 percent of those whose highest earned degrees were in social and physical sciences.

Of all employed individuals whose highest degrees were in S&E, 76.8 percent said their jobs were related to the fields of their highest degrees, and 45.7 percent said their jobs were closely related to their fields.[5] (See appendix tables 3-8 and 3-9.) The relatedness of a field of study to an individual’s job varies in ways that are mostly predictable by level, years since earning, and field of degree.

In the one- to four-year period after receiving their degrees, 73 percent of S&E doctorate-holders say that they have jobs closely related to the degrees they received compared with 67.4 percent of master’s recipients and 42 percent of bachelor’s recipients. (See figure 3-2.) This relative ordering of relatedness by level of degree holds across all periods of years since the recipients received their degrees. However, at every degree level, jobs held by degree recipients generally are less closely related to the field of degree earned.[6] There may be good reasons for this: individuals may change their career interests over time, gain skills in different areas while working, take on general management responsibilities, and forget some of their original college training—or some of

[4]Refers to highest degree received.

[5]Although these self-assessments by survey respondents are highly subjective, they may capture associations between training and scientific expertise not evident through occupational classifications. For example, an individual with an engineering degree but an occupational title of salesman may still use or develop technology.

[6]Ph.D.-holders of more than 25 years are an exception; the percentage of those holding jobs closely related to their degrees increases. This disparity may reflect differences in retirement rates.

Text table 3-1.
Employed scientists and engineers, by S&E employment status and field of highest degree: 1999

Employee characteristic	Employment status Total	S&E	Non-S&E
Total employed	10,981,600	3,540,800	7,440,800
No S&E degree	501,800	282,000	219,800
S&E degree	10,479,800	3,258,800	7,221,000
S&E is highest degree	7,980,000	3,003,200	4,976,800
Computer sciences and mathematics	1,045,800	537,200	508,600
Life and related sciences	1,287,700	361,700	926,000
Physical and related sciences	621,700	343,000	278,700
Social and related sciences	3,088,400	458,000	2,630,400
Engineering	1,936,400	1,303,300	633,100
Non-S&E is highest degree	2,499,800	255,600	2,244,200

NOTE: Details may not add to totals because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1999.

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their original college training may become obsolete. Given these possibilities, the career-cycle decline in the relevance of an S&E degree is modest.

When comparing 1993 data with 1999 data (see figure 3-3), each year demonstrates the same general pattern. However, given the better labor market conditions in 1999, a somewhat higher proportion of midcareer (10–24 years since receiving degree) S&E bachelor's degree-recipients and doctorate-holders said in 1999 that their jobs were closely related to their degrees. At the bachelor's degree level, an additional 11.5 percent of those who had received their degrees 15–19 years prior were in jobs closely related to their field of study. For Ph.D. recipients, the improvement was much smaller (4.7 percent) for those 20–24 years after receiving their degrees.

Differences in the percentages of those who said their jobs were closely related to their fields of degree are shown in figure 3-4 by level of degree and in figure 3-5 by major S&E disciplines for bachelor's recipients. Although mathematics and computer sciences are often combined into a single group, they are shown separately here because of their very different patterns. From one to four years after receiving their degrees, the percentage of S&E bachelor's degree-recipients who said their jobs were closely related to fields of degree earned ranged greatly—from 30.0 percent for those whose degree was in social sciences to 74.3 percent for those whose degree was in computer sciences. Between these extremes, most other S&E fields show similar percentages for recent graduates: 54.1 percent for physical sciences, 51.8 percent for mathematics, 54.9 percent for engineering, and 44.2 percent for life sciences.

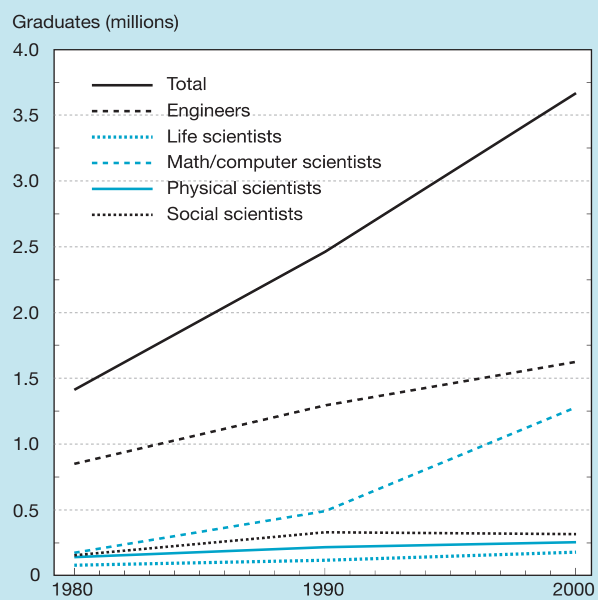
Growth of the S&E Workforce

Although Scientists and Engineers Statistical Data System data for the 1990s demonstrate limitations of using only occupation to measure the scope of the science and engineering (S&E) workforce, we depend on occupation classifications to examine S&E growth over extended time periods. By looking only at college graduates working in narrowly defined S&E occupations (excluding technicians and computer programmers) and employed outside academia,* S&E jobs increased by 159 percent between 1980 and 2000, totaling 3,664,000 nonacademic S&E occupations in 2000. (See figure 3-1.) This represents a 4.9 percent average annual growth rate, much more than the 1.1 percent average annual growth rate of the entire labor force.

Although every broad S&E occupational group grew between 1980 and 2000 (the lowest growth, 81 percent, occurred in physical sciences), the most explosive growth was in mathematics and computer sciences, which experienced a 623 percent increase (177,000 jobs in 1980 to 1,280,000 jobs in 2000).

*Another difficulty when using occupation to identify scientists and engineers in most data sources other than NSF/SRS's SESTAT is that many in academia are identified simply as "college professor" or by similar titles that do not indicate specialty. For that reason, the time trend examined here is only for those outside academic employment.

Figure 3-1.
College graduates in nonacademic S&E occupations



SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), tabulation of 1980 and 1990 U.S. Decennial Census Public Use Microdata Sample, March 2000 Current Population Survey.

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Text table 3-2.
People with S&E degrees who are employed in non-S&E occupations, by highest degree and relation of degree to job: 1999

Highest degree	Total in non-S&E occupations	Highest degree related to job (percent)		
		Closely	Somewhat	Not
Total[a]	4,976,900	33.2	34.1	32.7
Bachelor's ...	4,092,800	29.9	34.7	35.5
Master's	724,800	48.7	31.2	20.1
Doctorate	155,200	46.0	35.6	18.5

[a]Includes professional degrees.

NOTE: Details may not add to totals because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1999.

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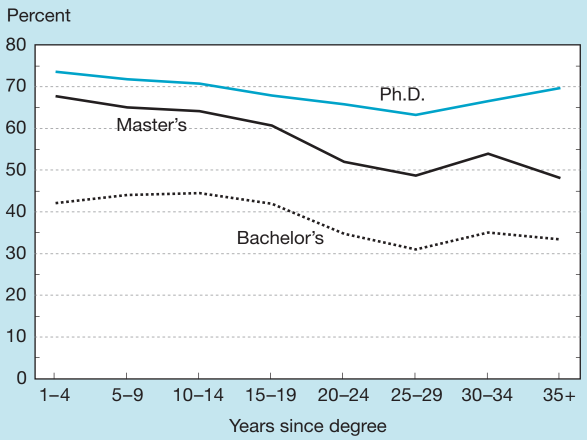
Figure 3-2.
Employed S&E degree-holders in jobs closely related to highest degree: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1999.

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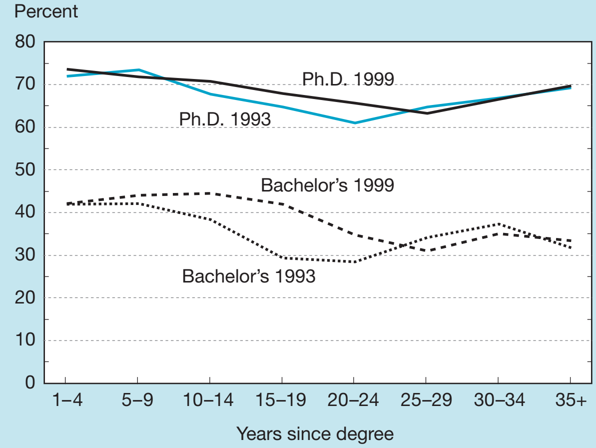
Figure 3-3.
Employed S&E degree-holders, in job closely related to highest degree, by years since degree: 1993 and 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT),1993 and 1999.

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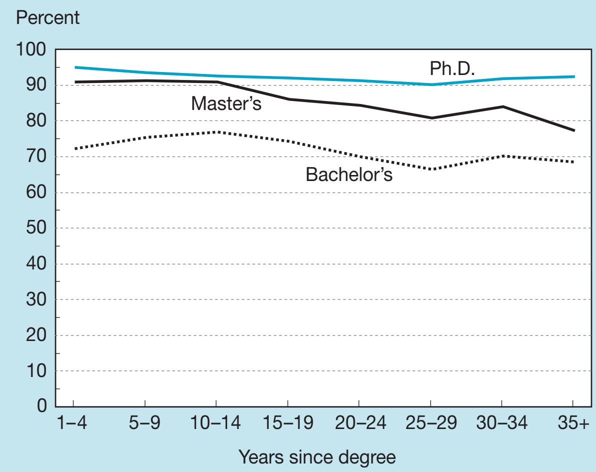
Figure 3-4.
Employed S&E degree-holders in jobs related to highest degree: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1999.

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Employment in Non-S&E Occupations

Slightly more than one-half of the 5 million S&E degree-holders working outside S&E in 1999 held management or administrative occupations (28 percent), sales and marketing jobs (15 percent), or non-S&E-related teaching positions (9 percent). (See text table 3-3.) Almost 89 percent of non-S&E teachers said that their work was at least somewhat related to their S&E degrees compared with 73 percent of managers or administrators and almost 51 percent of those employed in sales and marketing jobs.

Almost 82 percent of the 5 million S&E degree-holders not working in S&E occupations in 1999 reported their highest degree to be a bachelor's degree; 15 percent listed a master's degree, and 3 percent listed a doctorate. Approximately two-thirds of those with a bachelor's degree reported their jobs to be closely related to their highest degree field compared with four-fifths of doctoral and master's S&E degree recipients.

Employment in S&E Occupations

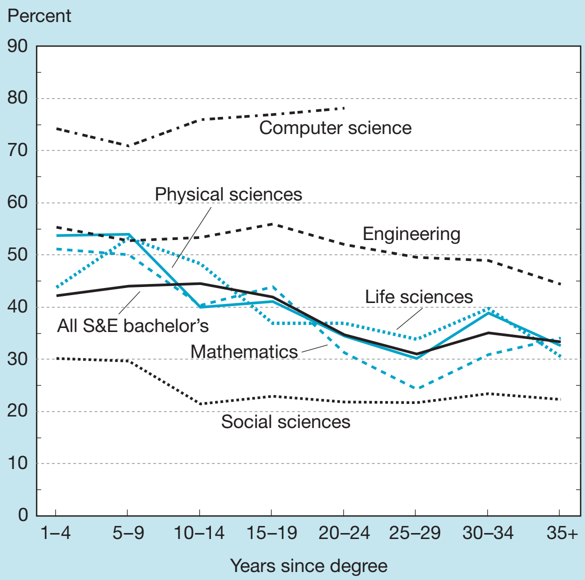
Of the 8 million scientists and engineers in the workforce in 1999 whose highest degree earned was in an S&E field, slightly more than one-third (3 million) were principally employed in S&E jobs. Additionally, 256,000 people trained in S&E whose highest degree was in a non-S&E field were employed in S&E occupations. Also, 282,000 college-educated individuals were employed in S&E occupations yet held no degrees in an S&E field.

Altogether, approximately 3.5 million individuals held S&E occupations in 1999. (See appendix table 3-10.) Engineers represented 39 percent (1.37 million) of the S&E positions, and computer scientists and mathematicians represented 33 percent (1.17 million). Physical scientists accounted for less than 9 percent of those working in S&E occupations in 1999.

By subfield, electrical engineers made up about one-fourth (362,000) of all those employed as engineers, whereas biologists accounted for about three-fifths (206,000) of employment in life sciences. In physical and social science occupations, chemists (122,000) and psychologists (197,000) were the largest occupational subfields, respectively.

Almost 56 percent of those employed in S&E jobs reported their highest degree earned to be a bachelor's degree, whereas 29 percent listed a master's degree and 14 percent listed a doctorate. About 1 percent reported other professional degrees to be their highest degree earned. Almost one-half of bachelor's degree-recipients were engineers; slightly more than one-third were computer scientists and mathematicians. (See text table 3-4.) These occupations were also the most popular among those with master's degrees (approximately 37 and 34 percent, respectively). Most doctorate-holders were employed as social scientists (26 percent), life scientists (25 percent), and physical scientists (18 percent).

Figure 3-5.
Employed S&E bachelor's degree-holders in job closely related to degree: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT). 1999.

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Unemployment

Of the approximately 3.6 million individuals with S&E occupations in the labor force in 1999, only 1.6 percent (56,000) were unemployed.[7] (See text table 3-5.) This compares with 4.4 percent for the 1999 U.S. labor force as a whole and 1.9 percent for all professional specialty workers. Unemployment for those with S&E occupations has dropped steadily since 1993, when it stood at 2.6 percent. The highest unemployment rate in 1999 was for physical scientists (1.9 percent), and the lowest rate was for computer scientists and

[7] The unemployment rate is the ratio of those who are unemployed and seeking employment to the total labor force (i.e., those who are employed plus those who are unemployed and seeking employment). Those who are not in the labor force (those who are unemployed and not seeking employment) are excluded from the denominator.

Text table 3-3.
People with S&E as highest degree who are employed in non-S&E occupations, by occupation and relation of degree to job: 1999

Occupation	Number	Highest degree related to job (percent)		
		Closely	Somewhat	Not
Total non-S&E occupations	4,976,900	33.2	34.1	32.7
Managers and administrators	1,416,000	30.0	43.0	27.0
Health related	322,200	58.1	27.1	14.7
Non-S&E teachers	452,400	65.8	22.7	11.5
Non-S&E postsecondary teachers	50,000	68.1	23.7	8.2
Social services	291,500	61.2	28.7	10.0
Technologists and technicians	337,600	46.6	34.1	19.3
Sales and marketing	764,400	13.3	37.5	49.2
Arts and humanities	122,500	21.7	38.1	40.2
Other	1,220,400	20.0	29.2	50.8

NOTE: Details may not add to total because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1999.

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Text table 3-4.
Distribution of individuals in S&E occupations, by level of highest degree: 1999
(Percentages)

Occupation	All degrees	Bachelor's	Master's	Doctorate	Professional
Total	100.0	100.0	100.0	100.0	100.0
Computer scientists and mathematicians	33.0	37.1	34.3	13.9	18.8
Life and related scientists	9.7	6.8	7.0	25.0	42.2
Physical and related scientists	8.4	7.0	7.1	17.5	1.4
Social and related scientists	10.3	3.6	15.1	26.2	30.4
Engineers	38.7	45.5	36.5	17.4	7.2

NOTE: Percentages may not add to 100 because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1999.

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Text table 3-5.
Unemployment rates for individuals in S&E occupations: 1993 and 1999
(Percentages)

Occupation	1993	1999
All S&E occupations	2.6	1.6
Computer scientists and mathematicians	1.9	1.2
Life and related scientists	1.7	1.3
Physical and related scientists	2.8	1.9
Social and related scientists	1.6	1.4
Engineers	3.4	1.8

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1993 and 1999.

See appendix tables 3-10 and 3-11.

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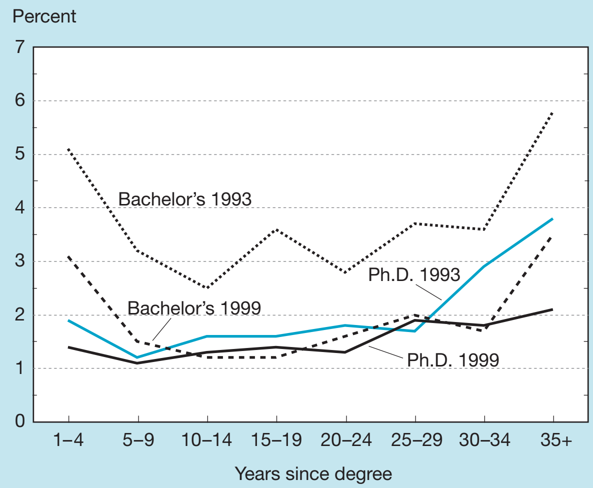
Figure 3-6.
Unemployment rates for S&E degree-holders by years since highest degree: 1993 and 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT),1993 and 1999.

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mathematicians (1.2 percent). By degree level, 1.6 percent of the scientists and engineers whose highest degree earned was a bachelor's degree were unemployed compared with 1.6 percent of those with a master's degree and 1.2 percent of those with a doctorate.

Unemployment rates during S&E degree-holders' careers are shown in figure 3-6 and indicate 1993 and 1999 rates for bachelor's and doctorate degree-holders. The generally stronger 1999 labor market had its greatest effect on bachelor's degree-recipients: among them, unemployment dropped by about 2 percentage points between 1993 and 1999 for all career levels. Although labor market conditions affect Ph.D. unemployment rates much less, significant reductions in unemployment rates between 1993 and 1999 occurred for Ph.D.-holders at both the beginning and end of their careers.

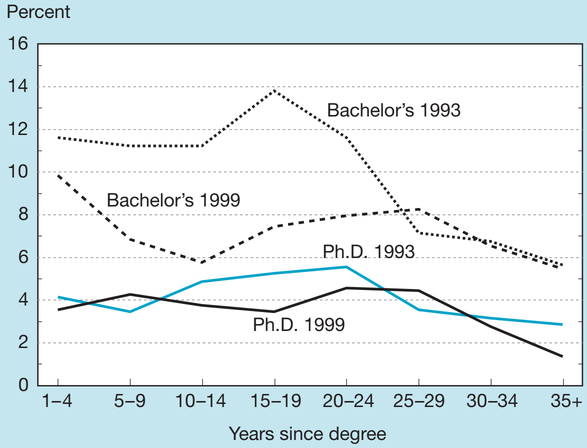
Similarly, labor market conditions from 1993 to 1999 had a greater effect on the portion of bachelor's degree-recipients who said they were working involuntarily outside their field of highest degree (involuntarily out of field, or IOF) than for Ph.D.-holders. (See figure 3-7.) However, the greatest differences in IOF rates for bachelor's degree-recipients occurs not at the beginning and end of one's career, but in midcareer. For Ph.D.-holders, few differences in IOF rates were noted between 1993 and 1999, and little change was noted during their careers.[8]

Sector of Employment

The private, for-profit sector is by far the largest provider of S&E employment. In 1999, approximately 74 percent of scientists and engineers with bachelor's degrees and 62 percent of those with master's degrees were employed in private, for-profit companies. (See appendix table 3-12.) The academic sector was the largest sector of employment for those with doctorates (48 percent). Sectors employing fewer S&E workers included educational institutions other than four-year colleges and universities, nonprofit organizations, and state or local government agencies.

[8] The decline in IOF rates for the oldest doctorate-holders may reflect in part lower retirement rates for those still working in their fields.

Figure 3-7.
Involuntarily out-of-field rates of S&E degree-holders, by years since highest degree: 1993 and 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1993 and 1999.

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For S&E occupations, the percentages of scientists and engineers employed in private, for-profit industry varied greatly. Although slightly more than three-fourths of both computer scientists and mathematicians and engineers (76 and 78 percent, respectively) were employed in this sector, only about one-fourth (27 percent) of life scientists and one-fifth (19 percent) of social scientists were so employed in 1999. Educational institutions employed the largest percentages of life scientists (48 percent) and social scientists (45 percent). See sidebar, "Educational Distribution of S&E Workers."

Who Performs R&D?

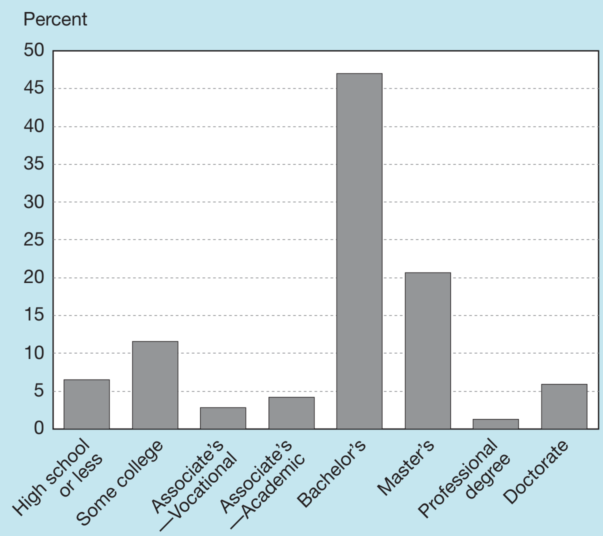
Although S&E-educated individuals use their acquired knowledge in various ways (e.g., teaching, writing, evaluating, and testing), they show a special interest in research and development (R&D). Figure 3-9 shows the distribution of individuals with S&E degrees by level of degree who report R&D as a major work activity. Those with doctorates make up only 5.6 percent of total S&E degrees achieved but represent 14.4 percent of those reporting R&D as a major work activity. Despite this, the majority of S&E degree-holders who report R&D as a major work activity have only bachelor's degrees (55.4 percent). An additional 27.4 percent have master's degrees, and 2.8 percent have professional degrees (mostly in medicine). Figure 3-10 shows the distribution of individuals with S&E degrees by field of highest degree who reported R&D as a major work activity. Those with engineering degrees constitute almost one-third (31.7 percent) of the total. Notably, 17.9 percent did not earn their highest degrees in S&E fields. In most cases, a person in this group has an S&E bachelor's degree and a higher degree in a professional field, such as business, medicine, or law.

Educational Distribution of S&E Workers

In 2000, more than two-thirds of those in nonacademic science and engineering (S&E) occupations had bachelor's degrees (47.0 percent) or master's degrees (20.7 percent). Discussions of the S&E workforce often focus on employees who hold doctorates. However, using United States Current Population Survey data to look at the educational achievement of those in S&E occupations outside academia in 2000, only 5.9 percent had doctorates. (See figure 3-8.)

In contrast, one-fourth of those in S&E occupations had not earned a bachelor's degree. Although technical issues of occupational classification may account for the size of the nonbaccalaureate S&E workforce, it is also true that many individuals who have not earned a bachelor's degree do enter the labor force with marketable technical skills. These skills come from technical or vocational school training (with or without earned associate degrees), college courses, and on-the-job training. In information technology (IT) (and to some extent in other occupations), employers are more frequently using certification exams to judge skills without reference to formal degrees.

Figure 3-8.
Educational distribution of those in nonacademic S&E occupations: 2000



SOURCE: U.S. Department of Commerce/Bureau of the Census, Current Population Survey, March 2000

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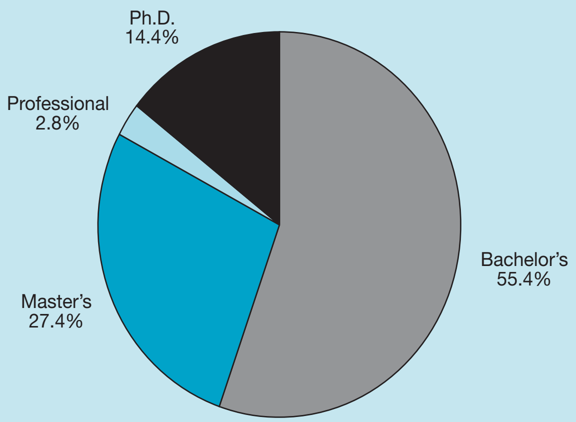
The percentages of S&E Ph.D.-holders reporting R&D as a major work activity are shown by field of degree and by years since receipt of Ph.D. in figure 3-11. The highest R&D rates over the career cycle are found in physical sciences and engineering; the lowest R&D rates are in social sciences. Al-

Figure 3-9.
Distribution of S&E R&D workers, by level of degree: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1999.

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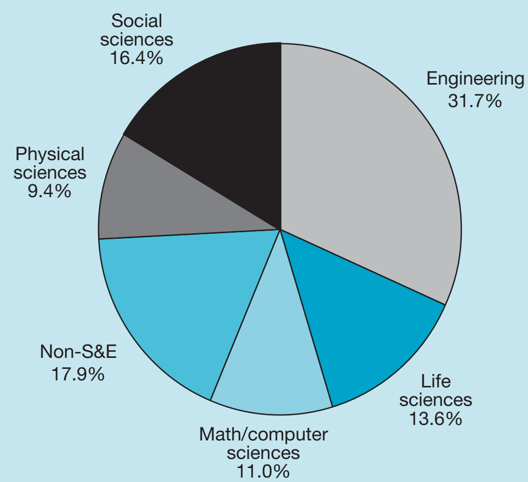
Figure 3-10.
Distribution of S&E R&D workers by field of highest degree: 1999



SOURCE: NSF/SRS 1999 Scientists and Engineers Statistical Data System file.

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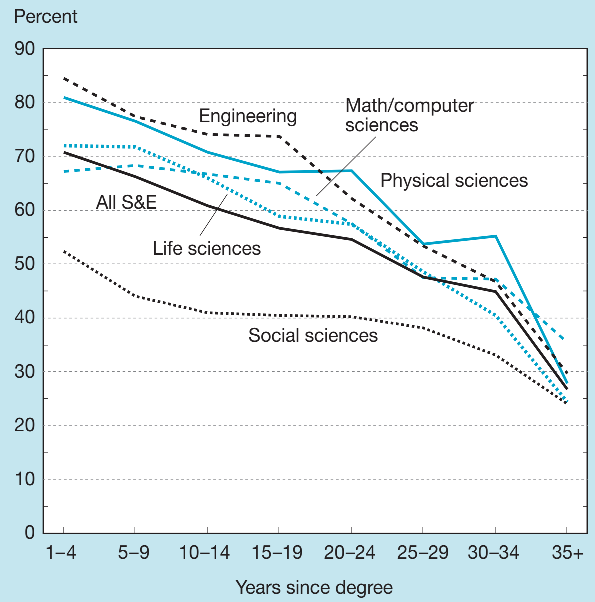
though the percentage of Ph.D.-holders engaged in R&D declines as years since receipt of degree increase, it remains greater than 50 percent in all fields except social sciences through 25 years since receipt of degree. The decline may reflect a normal career process of movement into management or other career interests.

Figure 3-11.
S&E Ph.D.-holders engaged in R&D as major work activity: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1999.

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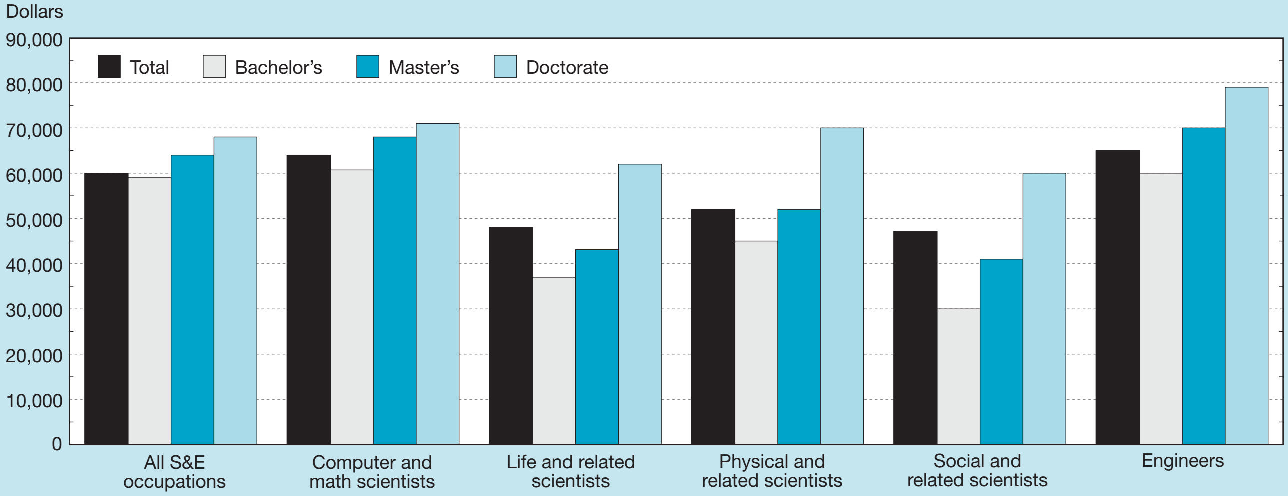
Salaries

In 1999, the median annual salary of employed bachelor's degree-recipients was $59,000; for master's recipients, it was $64,000; and for doctorate-holders, it was $68,000. (See figure 3-12 and appendix table 3-22.) Engineers commanded the highest salaries at the master's and doctorate levels, whereas computer scientists and mathematicians earned the highest salaries at the bachelor's level. The second highest salaries were earned by engineers at the bachelor's level, by computer scientists and mathematicians at the master's level, and by physical scientists at the doctorate level. The lowest median salaries reported were for social scientists at each degree level.

From 1993 to 1999, median salaries for those employed in S&E occupations rose about 25 percent. (See text table 3-6.) Computer scientists and mathematicians experienced the largest salary growth (37 percent), followed by engineers (30 percent). By degree level, median salaries for bachelor's degree-recipients rose by 31 percent, followed by master's degree-recipients (28 percent).

Median salaries for S&E job-holders also rise steadily as years pass from completion of the degree. For example, individuals who earned their bachelor's or doctoral degrees 5–9 years ago earned about $14,000 less in 1999 than those who received their degrees 15–19 years ago. For master's degree-recipients, the difference is $9,000. (See appendix table 3-26.)

Figure 3-12.
Median annual salaries of employed scientists and engineers by broad occupation and highest degree: 1999



See appendix table 3-22.

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Text table 3-6.
Median annual salaries of individuals in S&E occupations, by highest degree attained: 1993–99
(Dollars)

Highest degree	1993	1995	1997	1999
Total S&E	48,000	50,000	55,000	60,000
Bachelor's	45,000	48,000	52,000	59,000
Master's	50,000	53,500	59,000	64,000
Doctorate	54,800	58,000	62,000	68,000

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1993 and 1999.

See appendix tables 3-22, 3-23, 3-24 and 3-25.

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Women and Minorities in S&E

Demographic factors for women and minorities, such as age, time spent in the workforce, field of S&E employment, and highest degree level achieved, influence employment patterns.[9] To the extent that men differ from women and minorities differ from nonminorities on these factors, their employment patterns are also likely to differ. For example, the age distributions of women compared with men and of minorities compared with the majority are quite different. Because many women and minorities have entered S&E fields only recently, women and minority men generally are younger and have fewer years of experience. (See appendix table 3-34.) In turn, age and stage in career influence such employment-related factors as salary, rank, tenure, and work activity. In addition, employment patterns vary by field, and these field differences influence S&E employment, unemployment, salaries, and work activities. Highest degree earned, yet another important influence, particularly affects primary work activity and salary. This section examines the employment characteristics of representation in S&E, work experience, field of S&E, educational background, workforce participation, sectors of employment, and salaries for women and minorities in 1999.

Women Scientists and Engineers

Representation in S&E

Women made up almost one-fourth (24 percent) of the S&E workforce but close to one-half (46 percent) of the U.S. workforce in 1999. Although changes in NSF surveys do not permit analysis of long-term trends in employment, short-term trends reflect an increase in female doctorate-holders employed in S&E. In 1993, women made up 20 percent of the doctoral scientists and engineers in the United States; in 1995, they made up 22 percent; in 1997, they made up 23 percent; and in 1999, they made up 24 percent.[10] See sidebar, "Growth of Representation of Women, Minorities, and the Foreign Born in the S&E Workforce."

Work Experience

Many differences in employment characteristics between men and women are due in part to differences in time spent in the workforce. Women in the S&E workforce are younger on average than men; 50 percent of women and 36 percent of men employed as scientists and engineers in 1999 received their degrees within the past 10 years.

[9] Throughout this section, scientists and engineers are defined by field of employment, not by field of degree.

[10] For 1993 figures, see NSF 1996, p. 63; for 1995 figures, see NSF 1999b, p. 99.

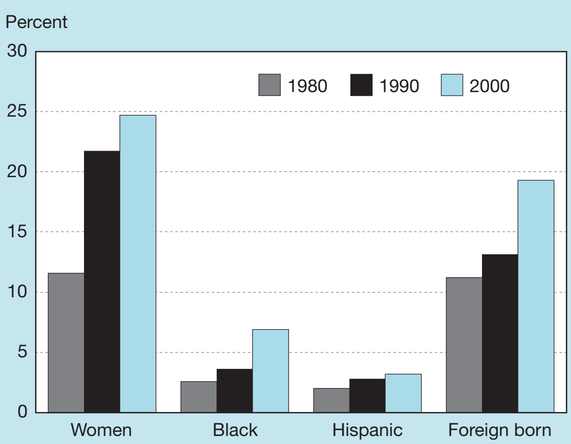
Growth of Representation of Women, Minorities, and the Foreign Born in the S&E Workforce

A longer view of the changes that have occurred in the sex and ethnic composition of the science and engineering (S&E) workforce can be achieved by examining data on college-educated individuals in nonacademic S&E occupations from the 1980 census, the 1990 census, and the March 2000 Current Population Survey. (See figure 3-13.) In 2000, the percentages of historically underrepresented groups in S&E occupations were still lower than the percentages of those groups in the total college-educated workforce:

- ♦ Women were 24.7 percent of the S&E workforce but 48.6 percent of the college-degreed workforce.
- ♦ Blacks were 6.9 percent of the S&E workforce but 7.4 percent of the college-degreed workforce.
- ♦ Hispanics were 3.2 percent of the S&E workforce but 4.3 percent of the college-degreed workforce.

However, these percentages are more than double of the shares of S&E occupations since 1980 for blacks (2.6 to 6.9 percent) and women (11.6 to 24.7 percent). Hispanic representation increased between 1980 and 2000, albeit at a lower rate (2.0 to 3.2 percent). Foreign-born college graduates also became a larger percentage of those in S&E jobs (11.2 percent in 1980 to 19.3 percent in 2000).

Figure 3-13.
College graduates in nonacademic S&E occupations: women and minorities



SOURCE: U.S. Department of Commerce, Bureau of the Census, 1980 and 1990 U.S. Decennial Census Public Use Microdata Sample, and March 2000 Current Population Survey.

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Field of S&E Occupation

As is the case in degree fields, representation of men and women differ in field of occupation. Women are more represented in some S&E fields than in others. For example, in 1999, women made up more than one-half of social scientists but only 23 percent of physical scientists and 10 percent of engineers. (See figure 3-14.) Within engineering, women are represented more in some fields than in others. For example, women constituted 15 percent of chemical and industrial engineers but only 6 percent of aerospace, electrical, and mechanical engineers. Since 1993, the percentages of women in most S&E occupations have gradually increased; the exception is mathematics and computer sciences, in which the percentage of women declined about 4 percent between 1993 and 1999.

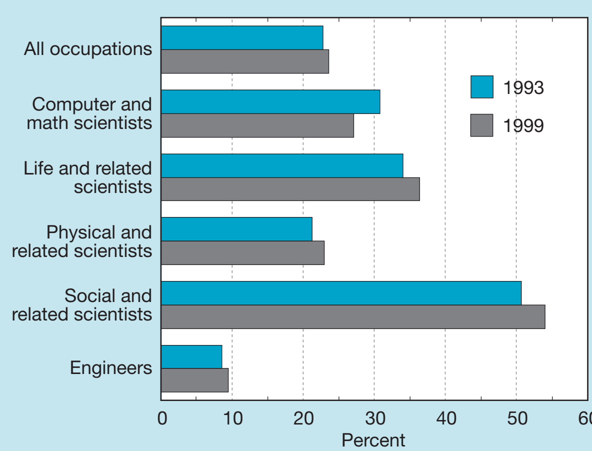
Educational Background

In many occupational fields, women scientists have a lower level of education than men. In the science workforce as a whole, 16 percent of women and 20 percent of men hold doctoral degrees. In biology, 26 percent of women and 40 percent of men hold doctoral degrees; in chemistry, 14 percent of women and 27 percent of men hold doctoral degrees; and in psychology, 22 percent of women and 42 percent of men hold doctoral degrees. Differences in highest degree achieved influence differences in type of work performed, employment in S&E jobs, and salaries. In engineering, the difference is much less: about 5 percent of women and 6 percent of men have doctoral degrees. (See NSF 1999f.)

Labor Force Participation, Employment, and Unemployment

Scientists and engineers who are men are more likely than women to be in the labor force, employed full time, and em-

Figure 3-14.
Women as proportion of S&E workforce, by broad occupation



See appendix tables 3-38 and 3-39.

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ployed in fields of highest degree achieved. Women are more likely than men to be out of the labor force, employed part time, and employed outside their fields. Some of these differences are due to differences in age distributions of men and women, and some are due to family-related reasons, such as the demands of a spouse's job or the presence of children.

The labor force participation rates for men and women with current or former S&E occupations are similar: 88 percent of men and 86 percent of women are in the labor force; the remaining percentages are those not in the labor force (i.e., not working and not seeking employment). (See appendix table 3-38.) Among those in the labor force, unemployment rates for men and women scientists and engineers are similar: 1.5 percent of men and 1.8 percent of women were unemployed in 1999. By comparison, the unemployment rate in 1993 was 2.7 percent for men and 2.1 percent for women. (See text table 3-7.)

Sector of Employment

Within fields, women are about as likely as men to choose industrial employment. For example, among physical scientists, 55 percent of women and 54 percent of men are employed in business or industry. (See appendix table 3-40.) Among employed scientists and engineers as a whole, women are less likely than men to be employed in business or industry but are more likely to be employed in educational institutions: 51 percent of women and 68 percent of men are employed in for-profit business or industry, but 27 percent of women and 14 percent of men are employed in educational institutions. These differences in sector of employment, however, are due to differences in field of degree. Women are less likely than men to be engineers or physical scientists, who tend to be employed in business or industry.

Text table 3-7.
Unemployment rates for individuals in S&E occupations, by sex and race/ethnicity: 1993 and 1999
(Percentages)

Sex and race/ethnicity	1993	1999
S&E occupations, total	2.6	1.6
Sex		
Male	2.7	1.5
Female	2.1	1.8
Race/ethnicity		
White	2.4	1.5
Black	2.8	2.6
Hispanic	3.5	1.8
Asian/Pacific Islander	4.0	1.5
Other	4.8	0.9

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1993 and 1999.

See appendix tables 3-38 and 3-39.

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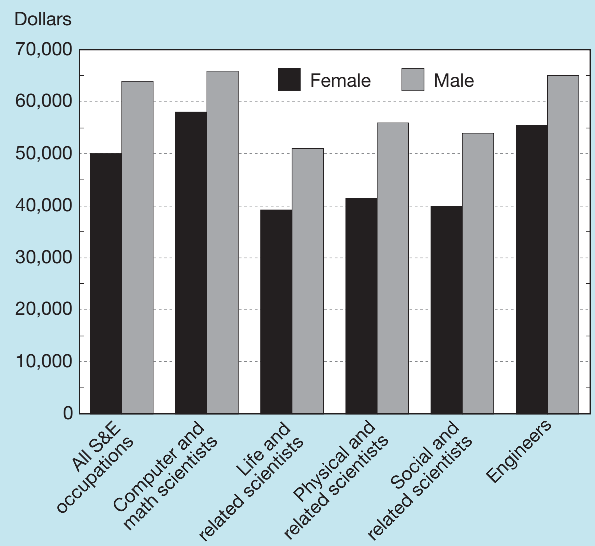
Salaries

In 1999, the median annual salary for women scientists and engineers was $50,000, about 22 percent less than the median salary for men ($64,000). (See figure 3-15.) Between 1993 and 1999, salaries for women scientists and engineers increased by 25 percent compared with an increase of 28 percent for men. (See text table 3-8.) These salary differentials could be due in part to several factors. Women were more likely than men to be working in educational institutions and social science occupations, to be working in nonmanagerial positions, and to have less experience, all factors that con-

Figure 3-15.
Median annual salaries of employed scientists and engineers, by broad occupation and sex: 1999



See appendix table 3-26. *Science & Engineering Indicators – 2002*

Text table 3-8.
Median annual salaries of individuals employed in S&E occupations, by sex and race/ethnicity
(Dollars)

Sex and race/ethnicity	1993	1995	1997	1999
S&E occupations, total	48,000	50,000	55,000	60,000
Sex				
Male	50,000	52,000	58,000	64,000
Female	40,000	42,000	47,000	50,000
Race/ethnicity				
White	48,000	50,500	55,000	61,000
Black	40,000	45,000	48,000	53,000
Hispanic	43,000	47,000	50,000	55,000
Asian/Pacific Islander	48,000	50,000	55,000	62,000
Other	43,300	49,700	49,000	52,000

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1993 and 1999.

See appendix tables 3-26, 3-27, 3-28 and 3-29.

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The NSB Task Force on National Workforce Policies for Science and Engineering

In October 2000, the National Science Board established the Task Force on National Workforce Policies for Science and Engineering to assess long-term national workforce trends and needs in S&E and their relationship to existing Federal policies and to recommend strategies that will address long-term S&E workforce needs. The task force will consider the following issues:

- how U.S. demographic trends, trajectories of S&E preparation and degree attainment, and availability of foreign scientists and engineers may affect the future S&E workforce;
- how data on industry demand—both for requisite skills and the numbers of workers who possess them—can better inform preparation, hiring, and retention of students at all levels for high-technology careers;
- how graduate training can be diversified to support aspirations that match opportunities, especially outside of research and of academia, while ensuring continued excellence in the traditional preparation of U.S. scientists and engineers; and
- how the mix of Federal law, such as immigration policy, Federal agency and state programs, higher education institution practices, and employer recruitment and other incentives affect student and worker choices related to S&E careers.

The report of the Task Force on National Workforce Policies For Science and Engineering is expected to be available in 2002. Further information about the work of the task force can be found on the Board's website at http://www.nsf.gov/nsb/.

tribute to salary differences. Among scientists and engineers in the workforce who have held their degrees for five years or less, the median annual salary for women was 83 percent of that for men in 1999.

Salary differentials varied by broad field. In computer science and mathematics occupations in 1999, women's salaries were approximately 12 percent less than men's salaries, whereas there was a 23 percent salary difference in life science occupations. In these respective occupations, women also reported the highest and lowest median salaries; their highest median salary was in computer science and mathematics occupations ($58,000), and their lowest was in life science occupations ($39,000).

Racial and Ethnic Minority Scientists and Engineers

Representation in S&E

With the exception of Asians, minorities make up a small portion of scientists and engineers in the United States.[11] Eleven percent of scientists and engineers in 1999 were Asian, although they constituted 4 percent of the U.S. population. Blacks, Hispanics, and American Indians as a group constituted 24 percent of the U.S. population but only 7 percent of the total S&E workforce in 1999.[12] Blacks and Hispanics each represented about 3 percent of scientists and engineers, and American Indians represented less than 0.5 percent. (See appendix tables 3-41 and 3-44.) Between 1993 and 1999, the portion of Asians in the S&E workforce increased by about 2 percent, whereas the portion of blacks, Hispanics, and American Indians remained virtually unchanged.

Work Experience

The work experience of minorities, including Asians, differs from that of white scientists and engineers. As noted earlier, such differences influence employment characteristics. About 33 percent of white scientists and engineers employed in 1999 had received their degrees within the previous 10 years compared with 46–52 percent of Asian, black, and Hispanic scientists and engineers.

Field of S&E Occupation

Asian, black, and American Indian scientists and engineers are concentrated in fields different from those for white and Hispanic scientists and engineers. Asians are less represented in social sciences than in other fields. In 1999, they were 4 percent of social scientists but more than 11 percent of engineers and computer scientists. Black scientists and engineers have higher representation rates in social sciences and in computer sciences and mathematics than in other fields. In 1999, they were 5 percent of social scientists, 4 percent of computer scientists and mathematicians, and approximately 3 percent of physical scientists, life scientists, and engineers. Although their representation is small, American Indians are concentrated in social sciences, making up 0.4 percent of social and life scientists and 0.3 percent or less of scientists in other fields in 1999. Hispanics are more proportionally represented among fields; they were approximately 2.5 to 4.5 percent of scientists and engineers in each field.

[11]The term "minority" includes all groups other than white; "underrepresented minorities" include three groups whose representation in S&E is less than their representation in the population: blacks, Hispanics, and American Indians/Alaskan Natives. In accordance with Office of Management and Budget guidelines, the racial and ethnic groups described in this section are identified as white and non-Hispanic, black and non-Hispanic, Hispanic, Asian/Pacific Islander, and American Indian/Alaskan Native. In text and figure references, these groups are identified as white, black, Hispanic, Asian, and American Indian.

[12] The S&E fields in which blacks, Hispanics, and American Indians earn their degrees influence participation in the S&E labor force. Blacks, Hispanics, and American Indians are disproportionately likely to earn degrees in social sciences (defined by NSF as degrees in S&E) and to be employed in social service occupations, such as social worker and clinical psychologist, which are defined by NSF as non-S&E occupations. See NSF 1999a for NSF's classification of S&E fields.

Educational Background

The educational achievement of scientists and engineers differs among racial and ethnic groups. On average, black and Hispanic scientists and engineers have a lower level of educational achievement than scientists and engineers of other racial and ethnic groups. A bachelor's degree is more likely to be the highest degree achieved for black and Hispanic scientists and engineers than for white or Asian scientists and engineers—in 1999, a bachelor's degree was the highest degree achieved for 61 percent of black scientists and engineers in the U.S. workforce compared with 56 percent of all scientists and engineers.

Labor Force Participation, Employment, and Unemployment

Labor force participation rates vary by race and ethnicity. Minority scientists and engineers are more likely than whites to be in the labor force (that is, employed or seeking employment). Between 89 and 93 percent of black, Asian, Hispanic, and American Indian scientists and engineers were in the labor force in 1999 compared with 86 percent of white scientists and engineers. (See appendix table 3-38.) Age somewhat explains these differences. On average, white scientists and engineers are older than scientists and engineers of other racial and ethnic groups: 28 percent of white scientists and engineers were age 50 or older in 1999 compared with 15–20 percent of Asians, blacks, and Hispanics. For those in similar age groups, the labor force participation rates of white and minority scientists and engineers are similar. (NSF 1999b.)

Although minorities are for the most part less likely than nonminorities to be out of the labor force, minorities in the labor force are more likely to be unemployed. In 1999, the unemployment rate of white scientists and engineers was somewhat lower than that of other racial and ethnic groups. (See text table 3-7.) The unemployment rate for whites was 1.5 percent compared with 1.8 percent for Hispanics, 2.6 percent for blacks, and 1.5 percent for Asians. In 1993, the unemployment rate for whites was 2.4 percent compared with 3.5 percent for Hispanics, 2.8 percent for blacks, and 4.0 percent for Asians.

The differences in 1999 unemployment rates are evident within fields of S&E as well as for S&E as a whole. For example, the unemployment rate for white engineers was 1.8 percent; for black and Asian engineers, it was 2.3 and 1.8 percent, respectively.

Sector of Employment

Racial and ethnic groups differ within employment sector due in part to differences in field of employment. Among employed scientists and engineers in 1999, 58 percent of blacks, 60 percent of Hispanics, and 56 percent of American Indians were employed in for-profit business or industry compared with 64 percent of white and 70 percent of Asians. (See appendix table 3-40.) Blacks and American Indians are concentrated in social sciences (a field that provides less opportunity for employment in business or industry) and are underrepresented in engineering (a field that provides greater opportunity for employment in business or industry). On the other hand, Asians are overrepresented in engineering; thus, they are more likely to be employed by private, for-profit employers.

Black, Hispanic, and American Indian S&E job-holders are also more likely than other groups to be employed in government (Federal, state, or local): 20 percent of black, 15 percent of Hispanic, and 18 percent of American Indian scientists and engineers were employed in government in 1999 compared with 12 percent of white and Asian scientists and engineers.

Salaries

Salaries for S&E job-holders vary among racial and ethnic groups. In 1999, for all scientists and engineers, the median salaries by racial and ethnic group were $61,000 for whites, $62,000 for Asians, $53,000 for blacks, $55,000 for Hispanics, and $50,000 for American Indians. (See figure 3-16 and text table 3-8.) These salary patterns are about the same as they were in 1993.

Within occupational fields and age categories, median salaries of scientists and engineers by race and ethnicity are not dramatically different and do not follow a consistent pattern. For example, in 1999, the median salary of 20- to 29-year-old engineers with bachelor's degrees ranged from $35,000 for American Indians to $46,000 for Hispanics. Among those between the ages of 40 and 49, the median salary ranged from $60,000 for Asians and Native Americans to $70,000 for whites. The median salary of engineers with bachelor's degrees in 1999 who had received their degrees within the past five years was $45,000 for all ethnicities. (See appendix table 3-26.) Among those who had received their degrees 20–24 years ago, the median salary was approximately $70,000 for all ethnicities. See sidebar, "Salary Differentials."

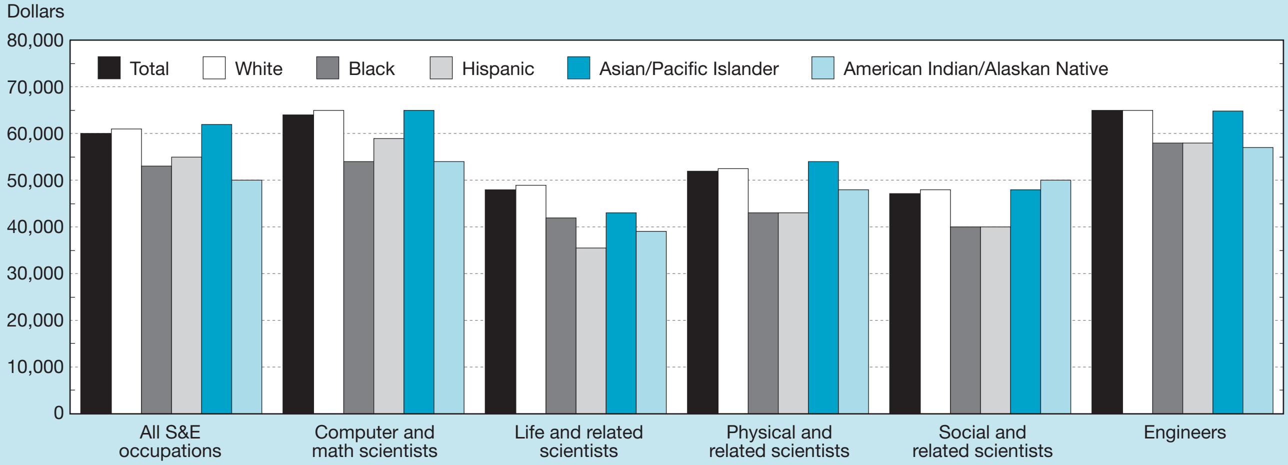
Labor Market Conditions for Recent S&E Degree-Holders

Recipients of Bachelor's and Master's Degrees

Recent recipients of S&E bachelor's and master's degrees form a key component of the U.S. S&E workforce: they account for almost one-half of the annual inflow to the S&E labor market (NSF 1990).[13] Recent graduates' career choices and entry into the labor market affect the supply and demand

[13] Data for this section are taken from the *1999 National Survey of Recent College Graduates*. This survey collected information on the 1999 workforce status of 1997 and 1998 bachelor's and master's degree recipients in S&E fields. Surveys of recent S&E graduates have been conducted biennially for NSF since 1978. For information on standard errors associated with survey data, see NSF (forthcoming b).

Figure 3-16.
Median annual salaries of scientists and engineers, by broad occupation and race/ethnicity: 1999



See appendix table 3-26.

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for scientists and engineers in the United States. This section offers insight into the labor market conditions for recent S&E graduates in the United States. Topics examined include graduate school enrollment rates, employment by level and field of degree, employment sectors, and median annual salaries.

Employment Versus Graduate School

In 1999, approximately one-fifth of 1997 and 1998 graduates who earned bachelor's or master's degrees were enrolled full time in graduate school. Students who had majored in physical and life sciences were more likely to be full-time graduate school students than were graduates with degrees in computer and information sciences and engineering. (See appendix table 3-45.)

Employment Related to Level and Field of Degree

Success in the job market varies significantly by level and field of degree. One measure of success is the likelihood of finding employment directly related to a graduate's field of study. Almost one-half of master's recipients but only one-fifth of bachelor's recipients were employed in their fields of study in 1999. Among both master's and bachelor's recipients, students who had received their degrees in either engineering or computer sciences were more likely to be working in their fields of study than degree recipients in other S&E fields, whereas students in social sciences were less likely than their counterparts in other S&E fields to have jobs directly related to their degrees.

Sector of Employment

The private, for-profit sector is the largest employer of recent S&E bachelor's and master's degree- recipients. (See text table 3-10.) In 1999, 63 percent of bachelor's degree-recipients and 57 percent of master's degree-recipients found employment in private, for-profit companies. The academic sector is the second largest employer of recent S&E graduates. Master's degree-recipients were more likely to be employed in four-year colleges and universities (12 percent) than were bachelor's degree-recipients (8 percent). The Federal sector employed only 5 percent of S&E master's degree-recipients and 4 percent of S&E bachelor's degree-recipients in 1999. Engineering graduates are more likely than science graduates to find employment in the Federal sector. Other sectors employing small numbers of recent S&E graduates include educational institutions other than four-year colleges and universities, nonprofit organizations, and state and local government agencies. Very small percentages of engineering bachelor's and master's recipients were self-employed (1 and 2 percent, respectively).

Employment and Career Paths

Career-path jobs are those that will help graduates fulfill their future career plans. As one might expect, S&E master's degree-recipients are more likely than S&E bachelor's degree-recipients to report having a career-path job. Approximately three-fourths of all master's degree-recipients and three-fifths of all bachelor's degree- recipients found a career-path job in 1999. Graduates with degrees in computer and information sciences or in engineering are more likely to find career-path jobs than graduates with degrees in other fields; about four-fifths of bachelor's and master's degree graduates in computer and information sciences and in engineering reported that they had found career-path jobs.

Salaries

Of recent bachelor's degree-recipients in sciences, in 1999, those with degrees in computer and information sciences earned the highest median annual salaries ($44,000); for graduates with degrees in engineering, those with degrees in electrical/electronics, computer, and communications engi-

Salary Differentials

Differences in salaries of women and ethnic minorities are often used as indicators of progress that individuals in such groups are making in science and engineering (S&E). Indeed, as shown in text table 3-9, these salary differences are substantial when comparing all individuals with S&E degrees by the level of degree: in 1999, women with S&E bachelor's degrees had full-time mean salaries that were 35.1 percent less than those of men with S&E bachelor's degrees.* Blacks, Hispanics, and individuals in other underrepresented ethnic groups with S&E bachelor's degrees had full-time salaries that were 21.9 percent less than those of non-Hispanic whites and Asians with S&E bachelor's degrees.** These raw differences in salary are lower but still large at the Ph.D. level (–25.8 percent for women and –12.7 percent for underrepresented ethnic groups). In contrast, foreign-born individuals with U.S. S&E degrees have slightly higher salaries than U.S. natives at the bachelor's and master's levels, but their salaries at the Ph.D. level show no statistically significant differences from those of natives.

However, differences in average age, work experience, field of degree, and other characteristics make direct comparison of salary and earnings statistics difficult. Generally, engineers earn a higher salary than social scientists, and newer employees earn less than those with more experience. One common statistical method that can be used to look simultaneously at salary and other differences is regression analysis.† Text table 3-9 shows estimates of salary differences for different groups after controlling for several individual characteristics.

Although this type of analysis can provide insight, it cannot give definitive answers to questions about the openness of S&E to women and minorities for many reasons. The most basic reason is that no labor force survey ever captures all information on individual skill sets, personal background and attributes, or other characteristics that

* For consistency with the other salary differences shown in text table 3-9, these salary differences were generated from regressions of ln (full-time annual salary) on just a dummy variable for membership in the group being examined. This corresponds to differences in the geometric mean of salary, not to differences in median salary as reported elsewhere in this chapter.

** "Underrepresented ethnic group" as used here includes individuals who reported their race as black, Native American, or other or who reported Hispanic ethnicity.

† Specifically presented here are coefficients from linear regressions using the 1999 SESTAT data file of individual characteristics upon the natural log of reported full-time annual salary as of April 1999.

Text table 3-9.
Salary differentials controlling for individual characteristics: 1999
(Percentages)

Variable	Bachelor's	Master's	Doctorate
Female (compared with male)			
All with S&E degrees	–35.1	–28.9	–25.8
Controlling for			
Age and years since degree	–27.2	–25.5	–16.7
Plus field of degree	–14.0	–9.6	–16.7
Plus occupation and employer characteristics	–11.0	–8.0	–8.4
Plus family and personal characteristics	–10.2	–7.4	–7.4
Plus gender-specific marriage and child effects	–4.6	NS	–3.1
Black, Hispanic, and other (compared with non-Hispanic white and Asian)			
All with S&E degrees	–21.9	–19.3	–12.7
Controlling for			
Age and years since degree	–13.0	–14.6	–4.7
Plus field of degree	–8.6	–6.7	–2.2
Plus occupation and employer characteristics	–7.3	–4.2	NS
Plus family and personal characteristics	–5.7	–3.3	NS
Foreign born with U.S. degree (compared with native born)			
All with S&E degrees	3.7	9.5	NS
Controlling for			
Age and years since degree	6.7	12.4	7.8
Plus field of degree	NS	NS	NS
Plus occupation and employer characteristics	NS	–2.8	–2.8
Plus family and personal characteristics	NS	–3.1	–2.7

NS = not significantly different from zero at $P = .05$

NOTE: Linear regressions on ln(full-time annual salary).

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1999.

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may affect compensation. In addition, even characteristics that are measurable are not distributed randomly among individuals. An individual's choice of degree field and occupation, for example, will reflect in part the real and perceived opportunities for that individual. The associations of salary differences with individual characteristics, not field choice and occupation choice, are examined here.

Effects of Age and Years Since Degree on Salary Differentials

Salary differences between men and women reflect to a large extent the lower average ages of women with degrees in most S&E fields. Controlling for differences in age and years since degree reduces salary differentials for women compared with men by about one-fourth at the bachelor's degree level (to –27.2 percent) and by about one-third at the Ph.D. level (to –16.7 percent).*

When controlling for differences in age and years since degree, even larger drops in salary differentials are found for underrepresented ethnic minorities. Such controls reduce salary differentials of underrepresented minorities compared with non-Hispanic whites and Asians by more than two-fifths at the bachelor's degree level (to –13.0 percent) and by nearly two-thirds at the Ph.D. level (to –4.7 percent).

Because foreign-born individuals in the labor force who have S&E degrees are somewhat younger on average than natives, controlling for age and years since degree moves their salary differentials in a positive direction—in this case, making an initial earnings advantage over natives even larger—to 6.7 percent for foreign-born individuals with S&E bachelor's degrees and to 7.8 percent for those with S&E Ph.D.s.

Effects of Field of Degree on Salary Differentials

Controlling for field of degree and for age and years since degree reduces the estimated salary differentials for women with S&E degrees to –14.0 percent at the bachelor's level and to –10.3 percent at the Ph.D. level.** These reductions generally reflect the greater concentration of women in the lower paying social and life sciences as opposed to engineering and computer sciences. As noted above, this identifies only one factor associated with salary differences and does not speak to why there are differences between males and females in field of degree or whether salaries are affected by the percentage of women studying in each field.

Field of degree is also associated with significant estimated salary differentials for underrepresented ethnic groups. Controlling for field of degree further reduces salary differentials to –8.6 percent for those with S&E bachelor's degrees and to –2.2 percent for those with S&E Ph.D.s. Thus, age, years since degree, and field of degree are associated with almost all doctorate-level salary differentials for underrepresented ethnic groups.

Compared with natives at any level of degree, foreign-born individuals with S&E degrees show no statistically significant salary differences when controlling for age, years since degree, and field of degree.

Effects of Occupation and Employer on Salary Differentials

Obviously, occupation and employer characteristics affect compensation.† Academic and nonprofit employers typically pay less for the same skills that employers pay for in the private sector, and government compensation falls somewhere between the two groups. Other factors affecting salary are relation of work performed to degree earned, whether the person is working in S&E, whether the person is working in research and development, size of employer, and U.S. region. However, occupation and employer characteristics may not be determined solely by individual choice, for they may also reflect in part an individual's career success.

When comparing women with men and underrepresented ethnic groups with non-Hispanic whites and Asians, controlling for occupation and employer reduces salary differentials only slightly beyond what is found when controlling for age, years since degree, and field of degree. For foreign-born individuals compared with natives, controls for occupation and employer characteristics also produce only small changes in estimated salary differentials, but in this case, the controls result in small negative salary differentials at the master's (–2.8 percent) and doctorate (–2.8 percent) levels.

Effects of Family and Personal Characteristics on Salary Differentials

Marital status, children, parental education, and other personal characteristics are often associated with differences in compensation. Although these differences may indeed involve discrimination, they may also reflect many subtle individual differences that might affect work productivity.‡ As with occupation and employer characteristics, controlling for these characteristics changes salary differentials only slightly at any degree level. However, most of the remaining salary differentials for women disappear when the regression equations allow for the separate effects of marriage and children for each sex. Marriage is associated with higher salaries for both men and women, but marriage has a larger positive association for men. Children have a positive association with salary for men but a negative association with salary for women.

* In the regression equation, this is the form: age, age^2, age^3, age^4 years since highest degree (YSD), YSD^2, YSD^3, YSD^4.

** Included were 20 dummy variables for NSF/SRS SESTAT field-of-degree categories (out of 21 S&E fields; the excluded category in the regressions was "other social science").

† Variables added here include 34 SESTAT occupational groups (excluding "other non-S&E"), whether a person said his job was closely related to his degree, whether a person worked in R&D, whether his employer had less than 100 employees, and the census region of the employer.

‡ Variables added here include dummy variables for marriage, number of children in the household younger than 18, whether the father had a bachelor's degree, whether either parent had a graduate degree, and citizenship. Also, sex, nativity, and ethnic minority variables are included in all regression equations.

Text table 3-10.
Employed 1997 and 1998 S&E bachelor's and master's degree recipients, by sector of employment and field of degree: 1999

		Sector of employment[a] (percent distribution)						
		Educational		Noneducational				
Degree[b]	Total employed (thousands)	Four-year college and university	Other institution	Private, for-profit company	Self-employed	Nonprofit organization	Federal Government	State or local government
S&E bachelor's	539.2	8	10	63	1	7	4	7
All sciences	442.4	9	12	58	2	9	4	8
All engineering	96.7	4	1	86	<0.5	1	5	4
S&E master's	118.1	12	9	57	2	7	5	7
All sciences	80.6	15	12	48	3	10	4	9
All engineering	37.6	8	<0.5	78	1	1	8	4

[a]Sector of employment in which the respondent was working on his or her primary job held on April 15, 1999. In this categorization, those working in four-year colleges and universities or university-affiliated medical schools or research organizations were classified as employed in the "four-year college and university" sector. Those working in elementary, middle, secondary, or two-year colleges or other educational institutions were categorized in the group "other institution." Those reporting that they were self-employed but in an incorporated business were classified in the "private, for-profit sector."

[b]For graduates with more than one eligible degree at the same level (bachelor's/master's), the degree for which the graduate was sampled was used.

NOTE: Details may not add to totals because of rounding. Percentages were calculated on unrounded data.

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), National Survey of Recent College Graduates, 1999.

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neering earned the highest salaries ($46,000). The same pattern was true for master's degree graduates: master's degree-recipients in computer and information sciences earned the highest median salaries ($58,000), as did those who earned master's degrees in electrical/electronics, computer, and communications engineering ($60,000).

Recipients of Doctoral Degrees

Analyses of labor market conditions for Ph.D.-holding scientists and engineers often focus on the ease or difficulty of beginning careers for new Ph.D. recipients. Several recent developments have contributed to these concerns, including demographic changes (which have slowed the growth of undergraduate enrollment), reductions in defense and research funding, growth in the importance of Ph.D. programs at foreign schools, and rates of Ph.D. production that approach or exceed the high levels realized at the end of the Vietnam draft.

Since the 1950s, the Federal Government has actively encouraged graduate training in S&E through numerous mechanisms. However, widespread unemployment or involuntary departure from S&E by many new Ph.D.-holding scientists and engineers could adversely affect the quality of scientific research in the United States. If labor market difficulties are real but temporary, promising students may be discouraged from pursuing degrees in S&E fields. To the extent that doctoral-level training provides higher level skills, this circumstance could eventually reduce the ability of industry, academia, and government to perform R&D. If labor market difficulties are long term, graduate education may need to be restructured to both maintain quality research and better prepare students for their real career options. In either case, when much high-level human capital goes unused, society loses potential opportunities for new knowledge and economic advancement, and individuals become frustrated with their careers. Of course, that some highly skilled individuals become either unemployed or employed IOF because they are unable to secure desired employment may reflect their unrealistic labor market expectations.

Most individuals who complete an S&E doctorate are looking for more than steady employment at a good salary. Their technical and problem-solving skills make them highly employable, but opportunity to do the type of work they want and for which they have been trained is important to them. For that reason, no single measure can satisfactorily describe the S&E labor market. Some of the available labor market indicators, such as unemployment rates, out-of-field and in-field employment, satisfaction with field of study, employment in academia, postdoctorate appointments, and salaries, are discussed below.

Aggregate measures of labor market conditions changed only slightly for recent doctoral degree-recipients in S&E (defined here as 1–3 years after receipt of degree). Unemployment fell from 1.5 percent in 1997 to 1.2 percent in 1999. (See text table 3-11.) Likewise, the portion of recent Ph.D. recipients reporting that they were either working outside their fields because jobs in their fields were not available or involuntarily working part time decreased slightly from 4.5 to 4.2 percent. These aggregate numbers mask numerous changes, both positive and negative, in many individual disciplines. In addition, IOF and unemployment rates in many fields moved in opposite directions.

Unemployment Rates

Even for relatively good labor market conditions in the general economy, the 1.2 percent unemployment rate for recent S&E Ph.D. recipients is very low; the April 1999 unemployment rate for all civilian workers was 4.4 percent.[14] In 1997, recent graduates in several Ph.D. disciplines had unemployment rates above 3 percent, which was still low but unusually high for a highly skilled group. Between 1997 and 1999, unemployment rates fell for recent Ph.D. recipients in most disciplines; the largest decrease was in chemistry, in which the unemployment rate fell from 3.5 to 0.5 percent. Unemployment rates of less than 1 percent were found in civil engineering (0.0 percent), mechanical engineering (0.3 percent), electrical engineering (0.76 percent), mathematics (0.7 percent), computer sciences (0.9 percent), physics and astronomy (0.0 percent), and economics (0.5 percent).[15]

[14]People are said to be unemployed if they were not employed during the week of April 15, 1999, and had either looked for work during the preceding four weeks or were laid off from a job.

[15]An unemployment rate of 0.0 does not mean that "zero" people in that field were unemployed; it means that the estimated rate from NSF's sample survey was less than 0.05 percent.

Text table 3-11.
Labor market rates for recent doctorate recipients one to three years after Ph.D.: 1997 and 1999
(Percentages)

	Unemployment rate		Involuntary out-of-field rate	
Ph.D. field	1997	1999	1997	1999
All S&E	1.5	1.2	4.5	4.2
Engineering	1.0	0.9	3.6	2.7
Chemical	1.7	1.7	5.8	1.8
Civil	0.0	1.5	5.5	0.0
Electrical	0.6	0.7	3.2	2.5
Mechanical	0.5	0.3	2.7	3.2
Other	1.6	0.9	3.0	3.6
Life sciences	1.7	1.1	2.6	2.5
Agriculture	2.2	0.0	7.3	3.1
Biological sciences	1.5	1.3	2.2	2.5
Computer sciences and mathematics	0.6	0.8	6.5	4.1
Computer sciences	0.7	0.9	2.1	1.8
Mathematics	0.6	0.7	11.0	6.2
Physical sciences	2.1	0.4	6.9	6.6
Chemistry	3.5	0.5	3.3	2.4
Geosciences	1.0	1.2	6.3	9.4
Physics and astronomy	0.7	0.0	12.2	11.1
Social sciences	1.6	2.1	5.4	5.7
Economics	0.9	0.5	5.2	4.2
Political science	2.6	3.4	7.9	11.6
Psychology	1.2	1.0	3.8	3.5
Sociology and anthropology	2.5	1.6	7.7	11.9
Other	2.5	1.9	7.1	4.4

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Survey of Doctorate Recipients, 1997 and 1999.

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Involuntarily Working Outside Field

Another 4.2 percent of recent S&E Ph.D. recipients in the labor force reported that they could not find (if they were seeking) full-time employment that was "closely related" or "somewhat related" to their degrees.[16] Although this measure is more subjective than the unemployment rate, the IOF rate often proves to be a more sensitive indicator of labor market difficulties for a highly educated and employable population. However, this tool is best used along with the unemployment rate as measures of two different forms of labor market distress.

The highest IOF rates were found for recent Ph.D. graduates in sociology and anthropology (11.8 percent) and political science (11.6 percent). These two fields also had unemployment rates that were among the highest. The lowest IOF rates were found in computer sciences (1.8 percent) and civil engineering (0.0 percent).

Tenure-Track Positions

Most S&E recipients do not ultimately work in academia, and in most S&E fields, this has been true for several decades. See chapter 10, "The Academic Doctoral S&E Workforce." In 1999, for S&E Ph.D.-holders four to six years since receipt of degree, 22.2 percent were in tenure-track or tenured positions at four-year institutions of higher education. (See text table 3-12.) Across fields, tenure-program academic employment for those four to six years since receipt of Ph.D. ranged from 6.5 percent in chemical engineering to 50.7 percent in political science. For Ph.D.-holders one to three years since receipt of degree, only 13.7 percent were in tenure programs, but this rate reflects the increasing use of postdoctoral appointments (or postdocs) by recent Ph.D.-holders in many fields.

Although academia must be considered just one possible sector of employment for S&E Ph.D.-holders, the availability of tenure-track positions is an important aspect of the job market for those who seek academic careers. The fall in rate of tenure-program employment for those four to six years since receipt of Ph.D. from 26.6 percent in 1993 to 22.2 percent in 1999 reflects both job opportunities in academia and alternative opportunities for employment. For example, one of the largest declines in tenure-program employment occurred in computer sciences (from 51.5 percent in 1993 to 31.6 percent in 1999), in which other measures of labor market distress are low, and computer science departments report difficulties recruiting faculty.[17] The attractiveness of other employment may also explain drops in tenure-program rates for several engineering disciplines. However, it is less likely to explain the smaller but steady drops in tenure-program employment rates in fields showing other measures of distress, such as physics and mathematics (both of which have large IOF rates) and biological sciences (which have low unem-

[16]Individuals were considered IOF if they said their jobs were not related to their degree because no jobs in their field were available or if they were part-time because a full-time job was not available. The IOF rate is a percentage calculated by dividing the number of such individuals by the total number in that segment of the labor force.

[17] See Computing Research Association (1997).

Text table 3-12.
Doctorate recipients holding tenure and tenure-track appointments at four-year institutions: 1993 and 1999
(Percentages)

	Years since receipt of doctorate			
	1993		1999	
Ph.D. field	1–3	4–6	1–3	4–6
All S&E	18.4	26.6	13.7	22.2
Engineering	16.0	24.6	7.3	15.2
Chemical	8.1	14.0	2.4	6.5
Civil	24.7	27.1	20.3	33.6
Electrical	17.6	26.9	3.7	11.9
Mechanical	13.5	29.5	6.4	15.1
Other	13.9	21.3	9.5	16.0
Life sciences	12.6	24.8	11.3	21.8
Agriculture	15.6	27.0	13.6	23.3
Biological sciences	12.1	24.8	10.9	22.0
Computer sciences and mathematics	39.7	54.1	20.8	36.7
Computer sciences	37.1	51.5	20.3	31.6
Mathematics	41.8	56.0	21.3	41.0
Physical sciences	9.7	18.2	8.1	15.2
Chemistry	7.7	16.3	9.4	14.2
Geosciences	12.7	26.2	14.3	24.0
Physics and astronomy	12.0	17.7	3.5	12.0
Social sciences	26.4	29.2	24.0	28.7
Economics	46.6	48.6	30.4	34.3
Political science	53.9	47.1	37.3	50.7
Psychology	12.7	15.5	14.9	16.0
Sociology and anthropology	37.9	46.9	33.4	43.4
Other	37.4	48.8	30.4	48.6

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Survey of Doctorate Recipients, 1993 and 1999.

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ployment and IOF rates but show other indications of labor market distress). Between 1993 and 1999, small increases in tenure-program rates for Ph.D. recipients four to six years since receipt of degree were found in chemistry, geosciences, psychology, and sociology and anthropology.

Relation of Occupation to Field of Degree

By strict definition of occupational titles, 17 percent of employed recent Ph.D. recipients were in occupations outside S&E, often performing administrative or management functions. When asked how related their jobs were to their highest degrees achieved, only a small portion of recent Ph.D. recipients employed in non-S&E occupations said that their jobs were unrelated to their degrees. (See text table 3-13.) By field, the percentages ranged from 1.5 percent for recent Ph.D. graduates in psychology to 14.2 percent for recent Ph.D. graduates in physics and astronomy.

Satisfaction With Field of Study

One indicator of the quality of employment available to recent graduates is simply their answers to this question: “If you had the chance to do it over again, how likely is it that you would choose the same field of study for your highest degree?” When asked of those who received S&E degrees one to five years after their previous degrees, 16.6 percent of Ph.D. recipients said they were “not at all likely” compared with 20.2 percent of bachelor’s recipients. (See text table 3-14.) This regret of field choice is lowest for recent Ph.D. recipients in computer sciences (6.8 percent), electrical engineering (9.8 percent), and social sciences (12.5 percent). The regret is greatest in physics (24.4 percent), chemistry (23.9 percent), and mathematics (22.4 percent).

Postdoctorate Appointments

A postdoctorate appointment (or postdoc) is defined here as a temporary position awarded in academia, industry, or government for the primary purpose of receiving additional research training. This definition has been used in the *Survey of Doctorate Recipients* when asking respondents about current and past postdoctorate positions they have held.[18] Data on postdoctorates are often analyzed in relation to recent Ph.D. labor market issues. Besides wanting to receive more training in research, recent Ph.D. recipients may accept temporary and usually lower paying postdoctorate positions because permanent jobs in their fields are not available.

Science and Engineering Indicators 1998 included an analysis of a one-time postdoctorate module from the *1995 Survey of Doctorate Recipients* that showed a slow increase

[18]It is clear, however, that the exact use of the term “postdoctorate” differs among academic disciplines, universities, and sectors that employ postdoctorates. These differences in usage have probably affected the self-reporting of postdoctorate status in the Survey of Doctorate Recipients.

Text table 3-13.
Recent Ph.D. scientists and engineers, by field of degree and relationship between Ph.D. field of study and occupation: 1999
(Percentages)

	Relation of occupation to degree field			
Ph.D. field	Same field	Other S&E	Related non-S&E	Nonrelated non-S&E
All S&E	71.1	11.9	14.4	2.6
Computer sciences	89.0	1.8	9.1	0.0
Engineering	75.0	17.8	5.5	1.7
Life sciences	65.2	7.5	24.1	3.2
Mathematics	84.2	3.1	6.3	6.4
Social sciences	74.6	5.8	16.9	2.7
Physical sciences	65.0	24.5	8.0	2.5

NOTE: Percentages may not add to 100 because of rounding.

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Survey of Doctorate Recipients, 1999.

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Text table 3-14.
Recent S&E graduates "not at all likely" to choose same field of study if they could do it over again by field and level of degree (one to five years after degree): 1997
(Percentages)

Field of degree	Bachelor's	Master's	Doctorate
All S&E fields	20.2	12.6	16.6
Engineering	11.3	12.6	14.8
Chemical	9.5	13.1	13.0
Civil	14.2	16.6	20.9
Electrical	8.3	6.5	9.8
Mechanical	10.2	16.6	16.0
Life sciences	16.8	13.9	18.3
Agriculture	20.7	18.4	20.7
Biological sciences	16.0	14.0	18.0
Computer sciences and mathematics	8.9	6.6	14.5
Computer sciences	6.8	5.3	6.8
Mathematics	12.0	10.3	22.0
Physical sciences	16.1	18.6	23.3
Chemistry	15.7	27.2	23.9
Geoscience	25.2	12.5	20.3
Physics	9.7	17.0	24.4
Social sciences	27.3	14.3	12.5
Economics	23.7	11.8	12.6
Political science	25.5	19.6	13.3
Psychology	28.4	13.7	10.8
Sociology and anthropology	31.2	15.7	15.5

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), SESTAT Data File, 1997.

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in the use of postdocs in many disciplines over time.[19] Additionally, in physics and biological sciences (fields with the most use of postdocs), median time spent in postdocs extended well beyond the one to two years found in most other fields.

[19] This was measured cross-sectionally by looking at the percentage of those in each graduation cohort who reported ever being in a postdoc position.

Data from 1999 show a small decline from 1995 in the percentage of recent S&E Ph.D. recipients entering postdoctorate positions—from 32.7 percent of 1994 graduates in 1995 to 31.5 percent of 1998 graduates in 1999. However, in the biological sciences, which account for about two-thirds of all postdocs, the postdoc rate one year after receipt of degree increased slightly from 59.6 to 61.2 percent. At the same time, physics, the other traditionally large postdoc field, experienced a decline in the incidence of postdocs one year after receipt of degree from 57.1 percent in 1995 to 47.0 percent in 1999. In fields other than physics or biological sciences, the postdoctorate rate one year after receipt of degree continued a slow decline from 21.2 percent in 1995 and 19.9 percent in 1997 to 18.9 percent in 1999.

Reasons for Taking a Postdoc

Postdocs in 1999 were asked to state their reasons for taking their current postdoctorate appointments; for all fields of degree, 32.1 percent gave "other employment not available" as their primary reason. (See text table 3-15.) Most respondents gave reasons consistent with the defined training and apprenticeship functions of postdoctorate appointments—e.g., 20.2 percent said that postdocs were generally expected for careers in their fields, 17.6 percent said they were seeking additional training in their fields, and 11.1 percent said they were seeking additional training outside their fields.

What Were 1997 Postdocs Doing in 1999?

Of those in postdoctorate positions in April 1997, 33.8 percent remained in a postdoctorate position in April 1999 (see text table 3-16)—a small reduction from the 38.0 percent of 1995 postdocs who were still postdocs in 1997 (*Science and Engineering Indicators 2000*). Only 15.1 percent transitioned from a postdoctorate to a tenure-track position at a four-year educational institution (down from 16.5 percent in 1997); 16.1 percent found other employment at an educational institution; 25.0 percent were at a for-profit firm; 6.0 percent were employed at a nonprofit institution or by government; and 1.4 percent were unemployed.

Text table 3-15.
Primary reason for taking current postdoc by field: 1999
(Percentages)

Ph.D. field	Additional training in Ph.D. field	Training outside Ph.D. field	Postdoc generally expected in field	Work with particular person or place	Other employment not available	Other
All S&E fields	17.6	11.1	20.2	15.9	32.1	3.2
Biological sciences	16.7	9.6	19.4	14.1	38.0	2.2
Chemistry	17.3	16.7	11.8	28.4	24.8	1.0
Engineering	20.5	13.8	22.4	20.5	16.2	6.6
Geoscience	12.0	6.1	31.5	38.2	12.2	0.0
Physics	10.6	13.2	25.8	8.4	38.3	3.6
Psychology	23.0	11.0	19.1	11.6	31.8	3.7

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Survey of Doctorate Recipients, 1999.

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No information is available on the career intentions of those in postdoctorate positions, but it is often assumed that a postdoc is valued most by academic departments at research universities. However, more postdocs in each field accept employment with for-profit firms than obtain tenure-track positions, and many tenure-track positions are at schools where a research record is not of central importance.

Salaries for Recent S&E Ph.D. Recipients

For all fields of degree, the median salary for recent S&E Ph.D. recipients in 1999 was $49,000, a change of 13.5 percent from 1997. By field, salaries ranged from a low of $34,000 in biological sciences to a high of $75,000 in electrical engineering. (See text table 3-17.) For all Ph.D. recipients, those in the top 10 percent of salary distribution (90th percentile) earned $80,000. The 90th percentile salaries varied by fields, from a low of $60,000 for those in sociology and anthropology to a high of $101,000 for those in computer sciences. At the 10th percentile, representing the lowest pay for each field, salaries ranged from $24,000 for those in biology to $51,000 for those in electrical engineering.

Salaries for recent S&E Ph.D. recipients by sector of employment are provided in text table 3-18. In 1999, the median salary for a postdoc one to three years since receipt of degree was $30,000, less than one-half the median salary for a recent Ph.D. recipient working for a private company ($68,000). Many of the salary differentials between S&E fields are narrower when examined within employment sector. For those in tenure-track positions, median salaries ranged from $38,000 for chemistry to $61,000 for chemical engineering. At private, for-profit companies, median salaries ranged from $54,000 for sociology and anthropology to $82,000 for computer sciences.

Changes in median salaries for recent bachelor's, master's, and Ph.D. graduates (defined here as one to five years since receipt of degree) are shown in text table 3-19. For all S&E fields, median salaries for recent Ph.D. recipients rose 4.7 percent from 1997 to 1999; for bachelor's and master's degree graduates, median salaries rose 0.0 percent and 2.5 percent, respectively. Several individual disciplines reflected larger increases for Ph.D. recipients, including double-digit increases in physics (10.4 percent), mathematics (12.5 percent), computer sciences (12.0 percent), and economics (10.3 percent). A decline in median salaries occurred in biology (–3.7 percent).

Text table 3-17.
Salary distribution for recent doctorate recipients (1–3 years after degree): 1999
(Dollars)

Ph.D. field	Percentile 10th	25th	Median	75th	90th
Total	26,100	35,000	48,800	65,000	80,000
Computer sciences	48,000	60,000	75,000	89,000	101,000
Mathematical sciences	35,000	38,000	45,000	60,000	75,000
Life sciences	24,000	28,000	35,000	50,000	67,000
Physical sciences	27,000	35,000	52,000	65,000	76,000
Social sciences	30,000	37,200	45,000	56,000	75,000
Engineering	42,700	56,000	66,700	76,000	88,000

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Survey of Doctorate Recipients, 1999.

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Age and Retirement

The size of the S&E workforce, its productivity, and opportunities for new S&E workers are all greatly affected by the age distribution and retirement patterns of the S&E workforce. For many decades, rapid increases in new entries led to a relatively young S&E workforce with only a small percentage near traditional retirement ages. This general pic-

Text table 3-16.
What 1997 postdocs were doing in 1999, by field
(Percentages)

Ph.D. field	Postdoc	Tenure-track at four-year institution	Other education job	For-profit job	Government job	Unemployed
All S&E fields	33.8	15.1	16.1	25.0	6.0	1.4
Biological sciences	45.0	13.9	13.9	18.0	5.5	1.8
Chemistry	21.9	6.8	6.9	52.0	5.8	3.5
Engineering	21.1	17.3	11.9	41.2	6.9	1.7
Physics	31.8	7.6	26.4	23.4	7.9	0.0
Psychology	21.2	18.5	23.1	32.8	9.6	0.0

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), merged 1997 and 1999 file from NSF's Survey of Doctorate Recipients.

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Text table 3-18.
Median salaries for recent U.S. doctorate recipients (1–3 years after degree), by sector of employment: 1999
(Dollars)

Ph.D field	Total	Private, noneducational	Government	Tenure-track at four-year institution	Postdoc	Other educational
Total	48,800	68,000	55,000	43,400	30,000	33,000
Computer sciences	75,000	82,000	66,000	53,000	—	60,000
Engineering	66,700	70,000	65,000	56,300	38,000	55,000
Life sciences	35,000	61,000	48,000	42,500	28,000	36,000
Mathematical sciences	45,000	60,500	55,200	39,500	40,000	38,000
Social sciences	45,000	53,000	52,400	40,000	30,500	35,000
Physical sciences	52,000	64,000	58,000	39,400	32,700	39,000

— = Fewer than 50 cases.

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Survey of Doctorate Recipients, 1999.

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Text table 3-19.
Change in median salaries for S&E graduates one to five years after degree: between 1997 and 1999
(Percentages)

Field of degree	Bachelor's	Master's	Doctorate
All S&E fields	0.0	2.5	4.7
Engineering	7.5	10.0	7.5
Chemical	11.9	5.2	3.1
Civil	5.7	4.2	9.1
Electrical	9.3	9.1	7.1
Mechanical	8.8	2.0	3.3
Life sciences	0.0	6.3	–2.8
Agriculture	0.0	11.3	10.1
Biological sciences	0.0	6.3	–3.7
Computer and mathematical sciences	13.5	7.7	9.7
Computer sciences	9.8	9.1	12.0
Mathematical sciences	3.5	12.5	12.5
Physical sciences	0.0	9.9	8.3
Chemistry	3.7	14.3	2.9
Geoscience	–3.6	–7.7	5.0
Physics	0.0	11.1	10.4
Social sciences	3.8	6.1	7.1
Economics	15.2	0.0	10.3
Political science	7.1	8.1	12.5
Psychology	4.2	1.3	1.2
Sociology and anthropology	4.2	3.3	12.6

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1997 and 1999.

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ture is rapidly changing as the individuals who earned S&E degrees in the late 1960s and early 1970s move into what is likely to be the latter part of their careers.

The possible effects of age distribution on scientific productivity are controversial. Increasing average age may mean increased experience and greater productivity among scientific workers. Others argue that it can reduce the opportunities for younger scientists to work independently. Indeed, in many fields, scientific folklore as well as actual evidence indicate that the most creative research comes from younger people. Ongoing research on the cognitive aspects of aging and the sociology of science is relevant to this debate but will not be reviewed here.

Age and Implications for the S&E Workforce

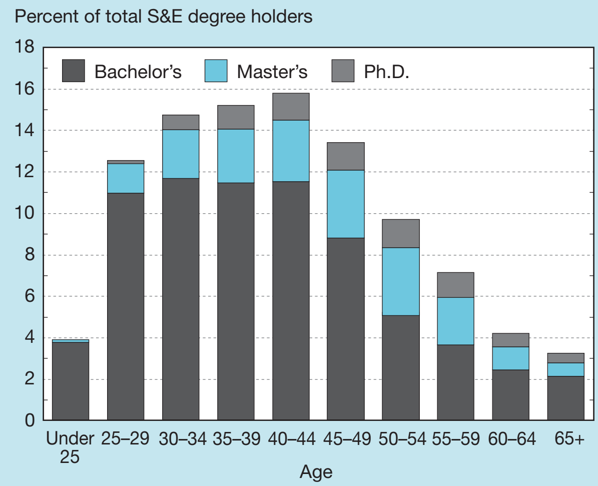
Age distribution among scientists and engineers in the workforce is affected by net immigration, morbidity, mortality, and, most of all, historical S&E degree production patterns. Age distributions for S&E degree recipients in 1999 are given by degree level and broad field of degree in appendix table 3-36. With the exception of new fields such as computer sciences (in which 56 percent of degree-holders are younger than age 40), the greatest population density of individuals with S&E degrees occurs between ages 40 and 49. This is seen in figure 3-17, which shows the age distribution of the S&E-degreed labor force broken down by level of degree. In general, most people in the S&E-degreed labor force are in their most productive years—the late 30s through early 50s, the largest group being ages 40–44. More than one-half of S&E-degreed workers are age 40 or older, and the 40–44 age group is nearly 4 times as large as the 60–64 age group.

This general pattern also holds true for those with Ph.D.s in S&E. Ph.D.-holders are somewhat older than those who have less advanced S&E degrees; this circumstance occurs because there are fewer Ph.D.-holders in younger age categories, reflecting that time is needed to obtain this degree. The greatest population density of S&E Ph.D.-holders occurs for those ages 45 to 54 years.

For all degree levels and fields, only a small portion of the S&E-degreed labor force was near traditional retirement ages: 11.8 percent overall were 55 or older. This circumstance suggests several likely effects on the future S&E labor force that are important and often overlooked:

- Barring large reductions in degree production or similarly large increases in retirement rates, the number of trained

Figure 3-17.
Age distribution of labor force with S&E highest degrees: 1999



See appendix table 3-36. *Science & Engineering Indicators – 2002*

scientists and engineers in the labor force will continue to increase for some time. The number of individuals currently receiving S&E degrees greatly exceeds the number of S&E-degreed workers near traditional retirement ages.

- Barring large increases in degree production, the average age of S&E-degreed workers will rise.
- Barring large reductions in retirement rates, the total number of retirements among S&E-degreed workers will dramatically increase over the next 20 years. This may be particularly true for Ph.D.-holders because of the steepness of their age profile.

Retirement Patterns for the S&E Workforce

The retirement behavior of individuals can differ in complex ways. Some individuals "retire" from a job while continuing to work full or part time, sometimes for the same employer, whereas others leave the workforce without a "retired" designation from a formal pension plan. Three ways of thinking about changes in workforce involvement for S&E degree-holders are summarized in text table 3-20: leaving full-time employment, leaving the workforce, and retiring from a particular job.

By age 62, 50 percent of S&E bachelor's and master's degree-recipients were not employed full time. For S&E Ph.D.-holders, this 50 percent mark was not reached until age 66, three years later. Longevity also differs by degree level when measuring those leaving the workforce entirely: one-half of S&E bachelor's and master's degree-recipients left the workforce entirely by age 65, but Ph.D.-holders did not do so until age 68. Formal retirement also occurs at somewhat higher ages for Ph.D.-holders: more than 50 percent of S&E bachelor's and master's degree-recipients "retired" from employment by age 63 compared with age 66 for S&E Ph.D.-holders.

Data on S&E degree-holders leaving full-time employment by ages 55 to 69 are shown in figure 3-18. For all degree levels, the portion of S&E degree-holders who work full time declines fairly steadily by age. After age 55, full-time employment for S&E doctorate-holders becomes significantly greater than for bachelor's and master's degree-recipients. At age 69, more than 27 percent of S&E Ph.D.-holders work full time compared with 13 percent of bachelor's or master's degree-recipients.

Academic employment may be one reason for a slower retirement rate among Ph.D.-holders. Text table 3-21 shows rates at which S&E Ph.D.-holders left full-time employment by sector of employment between 1997 and 1999.[20] Within each age group (except ages 66–70), a smaller portion of S&E Ph.D.-holders employed in 1997 at four-year colleges or universities or by government left full-time employment com-

[20] As a practical matter, it would be difficult to calculate many of the measures of retirement used previously in this chapter by sector of employment. However, a two-year transition rate can be calculated using the NSF/SRS SESTAT data file matched longitudinally at the individual level.

Text table 3-20.
Retirement ages for holders of S&E highest degrees: 1999

Highest degree	First age at which more than 50 percent are: Not working full time	Not in labor force	Retired from any job
Bachelor's	62	65	63
Master's	62	65	62
Doctorate	66	68	66

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1999.

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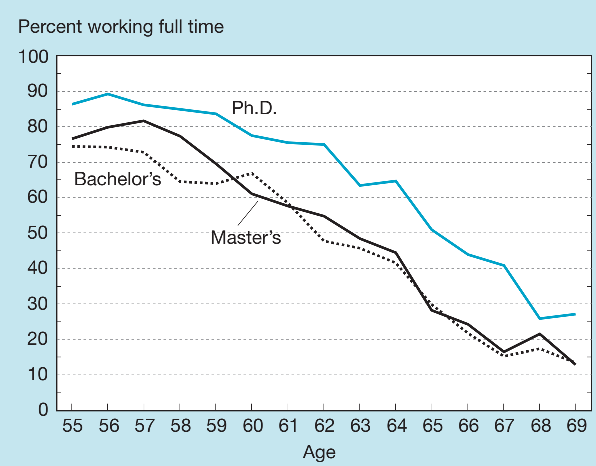
Figure 3-18.
Older S&E degree holders working full time: 1999



See appendix table 3-50. *Science & Engineering Indicators – 2002* pared with S&E Ph.D.-holders employed by for-profit companies and in all sectors combined.

Although slower retirement for S&E Ph.D.-holders (particularly in academia) is significant and of some policy interest, it is important to recognize that this does not mean that academic or other Ph.D.-holders seldom retire. Indeed, figure 3-18 indicates that their retirement patterns are similar to those for bachelor's and master's degree-recipients; retirement for Ph.D.-holders is just delayed two or three years. Even the two-year transition rates for academia in text table 3-21 show more than 40 percent of those ages 66–70 leaving full-time employment.

Although many S&E degree-holders who formally "retire" from one job continue to work full or part time, this occurs most often among those younger than age 63. (See text table 3-22.) The drop in workforce participation among the "retired" is more pronounced for part-time work; i.e., older retired S&E workers are more likely to be working full time than part time. Retired Ph.D. scientists and engineers follow this pattern, albeit with somewhat greater rates of postretirement employment than shown by bachelor's and master's degree-recipients. See sidebar, "Are Information Technology Careers Difficult for Older Workers?"

Text table 3-22.
S&E-degreed individuals who have "retired" but continue to work: 1999
(Percentages of those retired)

Age (years)	Bachelor's: Part time	Bachelor's: Full time	Master's: Part time	Master's: Full time	Ph.D.: Part time	Ph.D.: Full time
50–55	12.1	52.9	12.5	66.8	16.9	57.0
56–62	14.4	27.8	21.3	36.9	17.0	38.7
63–70	14.5	8.3	17.1	11.9	19.3	11.6
71–75	8.1	8.4	11.9	3.3	15.2	6.1

Highest degree

NOTE: Retired means those who said they had ever retired from any job.

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1999.

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Projected Demand for S&E Workers

During the 2000–2010 period, employment in S&E occupations is expected to increase about three times faster than the rate for all occupations. (See text table 3-23.) Although the economy as a whole is expected to provide approximately 15 percent more jobs over this decade, employment opportunities for S&E jobs are expected to increase by about 47 percent (about 2.2 million jobs).

Approximately 86 percent of the increase in S&E jobs will likely occur in computer-related occupations. Overall employment in these occupations across all industries is expected to increase by about 82 percent over the 2000–2010 decade, adding almost 1.9 million new jobs. The number of jobs for computer software engineers is expected to increase from 697,000 to 1.4 million, and employment for computer systems analysts is expected to grow from 431,000 to 689,000 jobs.

Text table 3-21.
Employed, 1997 S&E doctorate holders leaving full-time employment by 1999: by sector of employment in 1997
(Percentages)

Age in 1997 (years)	All sectors	Four-year schools	For-profit company	Government
51–55	5.6	4.1	6.4	3.9
56–60	9.5	5.1	17.3	5.8
61–65	21.6	18.3	33.5	19.8
66–70	45.1	43.2	38.4	64.7
71–73	32.6	29.7	—	—

— = Insufficient sample size for estimate

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1997 and 1999.

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Within engineering, environmental engineering is projected to have the biggest relative employment gains, increasing by 14,000 jobs, or about 27 percent. Computer hardware engineering is also expected to experience above-average employment gains, growing by 25 percent. Employment for all engineering occupations is expected to increase by less than 10 percent.

Job opportunities in life science occupations are projected to grow by almost 18 percent (33,000 new jobs) over the 2000–2010 period; at 27 percent (10,000 new jobs), medical science occupations are expected to experience the largest growth. Employment in physical science occupations is expected to increase by about 18 percent (from 239,000 to 283,000 jobs); slightly less than one-half of these projected job gains are for environmental scientists (21,000 new jobs).

Social science occupations are expected to experience above-average growth (20 percent) over the decade largely due to the employment increases anticipated for market and survey researchers (27 percent, or 30,000 new jobs). Demand for psychologists is also projected to be favorable (18 percent, or 33,000 new jobs).

The Global S&E Workforce and the United States

"There is no national science just as there is no national multiplication table." —Anton Chekov (1860–1904)

Science is a global enterprise. The common laws of nature cross political boundaries, and the international movement of people and knowledge made science global long before "globalization" became a label for the increasing interconnections among the world's economies. The United States (and other countries as well) gains from new knowledge discovered abroad

Are Information Technology Careers Difficult for Older Workers?

Compared with other science and technology careers, many assert that information technology (IT) is more hostile toward older workers. It has been claimed that cultural factors associated with a younger average age in IT occupations, on-the-job time pressures often associated with short project cycles, and rapid skill obsolescence associated with rapid changes in technology all adversely affect conditions for older IT workers. Recent information on this issue follows:

- ♦ The unemployment rate in 1999 for workers older than age 40 who had computer science degrees (any level) was 1.7 percent, greater that the 0.9 percent unemployment rate for those age 40 and younger with computer science degrees. However, this is a low rate of unemployment and is lower than the 1.9 percent unemployment rate found for non-IT science and engineering (S&E) graduates over age 40.
- ♦ Looking more broadly at all S&E graduates in IT occupations, IT workers over age 40 had an unemployment rate of 1.8 percent compared with 0.6 for younger IT workers and 1.8 percent for other S&E-trained workers over age 40.
- ♦ Looking at all college-educated IT workers (including non-S&E) between 1988 and 1993, those over age 40 left computer occupations at a much lower rate (14.1 percent) than did IT workers under age 25 (24.7 percent), and they left at about the same rate as IT workers ages 25–40 (14.3 percent).
- ♦ College-educated IT workers over age 40 faced greater risk of layoff during the 1988–1993 period: about 10.4 percent of 1988 computer occupation holders over age 40 were laid off during this five-year period compared with a 9.0 percent layoff rate for all college-educated computer workers and a 4.4 percent layoff rate for other college graduates.

Examining various data sources on IT workers and taking public testimony, a recent National Academy of Sciences Panel on the Information Technology Workforce concluded in part that:

> [T]he data are insufficient to establish either the presence or absence of age discrimination.. . . With all that said, the committee believes that the nation cannot afford to underutilize valuable human resources. . .and the differential experiences of older IT workers indicates some likelihood that this qualified segment of the workforce is not being fully utilized.

Text table 3-23.
Total S&E jobs: 2000 and projected 2010
(Numbers in thousands of jobs)

Occupation	2000	2010	Change
Total, all occupations	145,571	167,754	22,183
All S&E occupations	4,706	6,904	2,197
Scientists	3,241	5,301	2,059
Life scientists	184	218	33
Computer and mathematical occupations	2,408	4,308	1,900
Computer specialists	2,318	4,213	1,895
Mathematical science occupations	89	95	5
Physical scientists	239	283	44
Social scientists	410	492	82
Engineers	1,465	1,603	138

See appendix table 3-53. *Science & Engineering Indicators – 2002*

and from increases in foreign economic development. U.S. industry also increasingly relies on R&D performed abroad. The nation's international economic competitiveness, however, depends upon the U.S. labor force's innovation and productivity.

Other chapters in *Science and Engineering Indicators 2002* provide indirect indicators on the global labor force: production of new scientists and engineers through university degree programs is reported in chapter 2, and indicators of work performed by the global S&E labor force are provided in the chapter's discussion of international patenting activity and in chapter 5's data on R&D expenditures.

Few direct measures of the global S&E labor force exist. One source of data is the reports on the number of researchers in Organisation for Economic Co-operation and Development (OECD) member countries. From 1993 to 1997, the number of reported researchers in OECD countries increased by 23.0 percent (a 5.3 percent average annual rate) from approximately 2.46 million to 3.03 million. (See figure 3-19.) During this same period, comparable U.S. estimates increased 11.8 percent (a 3.7 percent average annual rate) from approximately 965,000 to 1.11 million. Although researchers in the United States, Japan, and the European Union made up 85.7

percent of the OECD total in 1997, the greatest growth in researchers came from other OECD countries, increasing 120 percent, or from 196,000 to 433,000.[21]

It is not, however, only OECD countries that have scientists and engineers. Figure 3-20 shows an estimate from disparate data sources during the 1990s of the global distribution of tertiary education graduates—roughly equivalent in U.S. terms to those who have earned at least technical school or associate degrees but also including all degrees up to Ph.D.[22] About one-fifth of the estimated 240 million tertiary graduates in the labor force were in the United States. However, of the 10 countries with the largest number of tertiary graduates, 3 are non-OECD: Russia, China, and India.

Migration of Scientists and Engineers to the United States

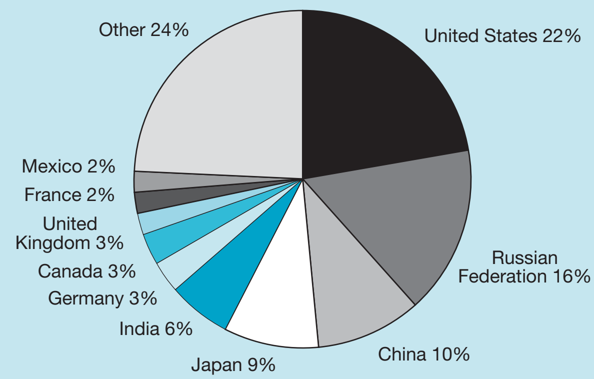
Migration of skilled S&E workers across borders is increasingly seen as a major determinant of the quality and flexibility of the labor force in most industrial countries. The knowledge of scientists and engineers can be transferred across national borders more easily than other skills. Additionally, any cutting-edge research or technology inevitably creates unique sets of skills and knowledge that can be transferred through the physical movement of people. The United States has benefited and continues to benefit greatly from this international flow of knowledge and personnel.

In April 1999, 27 percent of doctorate-holders in S&E in the United States were foreign born. (See text table 3-24.)[23] The lowest percentage of foreign-born doctorate-holders was in psychology (7.6 percent), and the highest percentage was in civil engineering (51.5 percent). Almost one-fifth (19.9 percent) of those with master's degrees in S&E were foreign born. Even at the bachelor's degree level, 9.9 percent of those with S&E degrees were foreign born; the largest percentages of degrees were in chemistry (14.9 percent), computer sciences (15.2 percent), and engineering (14.6 percent).

Origins of S&E Immigrants

Immigrant scientists and engineers come from various countries. Countries contributing more than 30,000 natives to the 1.5 million S&E degree-holders in the United States are shown in figure 3-21 by S&E doctorate and by high degree achieved in S&E. Although no one source country dominates, of those with S&E high degrees, 8 percent came from India, 7 percent came from China, 4 percent came from the Philippines, and 4 percent came from Germany (including

Figure 3-20.
Global distribution of workers with tertiary education: 1990–98



NOTES: Estimates are based on various original data sources and reporting years and are not appropriate for direct comparisons between countries but rather as a rough indicator of the global high-education workforce. No data available from countries representing around 10 percent of global population. "Tertiary education" roughly corresponds to an associate degree in the United States.

SOURCES: World Bank World Development Indicators, China National Bureau of Statistics: 1999 China Statistical Yearbook, Insituto Brasilerio de Geografia e Estatistica.

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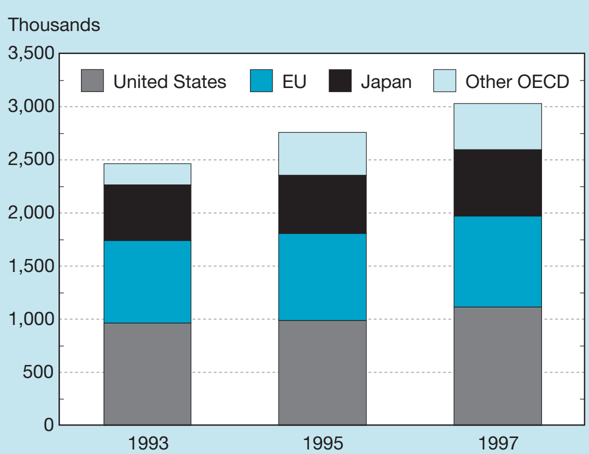
Figure 3-19.
Total researchers in OECD countries



EU = European Union

OECD = Organisation for Economic Co-operation and Development

SOURCE: Organisation for Economic Co-operation and Development Main S&E Indicators.

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[21] Although these numbers represent OECD staff estimates of total researchers in all member countries, the rapid growth of "other OECD" may represent in part improvements in reporting.

[22] The primary data source used is World Bank data on labor size and percentage of the labor force with a tertiary education, supplemented with data from various national data agencies. However, these data come from different years for different countries and are the result of estimates from very different national data collection systems. Hence, these data are not suitable for making direct comparisons between countries. In addition, data were not available from countries representing about 10 percent of the global population.

[23] Because NSF's demographic data collection system is unable to refresh its sample of those with S&E degrees from foreign institutions (as opposed to foreign-born individuals with a new U.S. degree, who are sampled) more than once per decade, counts of foreign-born scientists and engineers are likely to be underestimates. Foreign-degreed scientists and engineers are included in the 1999 estimate only to the extent that they were in the United States in April 1990. In 1993, 34.1 percent of foreign-born doctorate recipients in S&E and 49.1 percent of foreign-born bachelor's recipients in S&E had acquired their degrees from foreign schools.

Text table 3-24.
Foreign-born S&E-trained U.S. scientists and engineers, by field of highest degree and highest degree level: 1999
(Percentages)

Field of highest degree	Total labor force	Bachelor's	Master's	Doctorate
All S&E	12.2	9.9	19.9	27.0
Engineering	19.8	14.6	31.1	44.6
Chemical	20.2	14.9	34.9	40.8
Civil	21.2	16.1	35.5	51.5
Electrical	23.3	18.3	33.5	47.2
Mechanical	16.5	11.6	33.4	49.2
Other	17.0	11.3	24.2	40.9
Life sciences	11.7	8.8	13.7	26.1
Agriculture	7.9	5.4	14.9	22.7
Biological sciences	13.3	10.4	14.0	27.0
Computer and mathematical sciences	17.1	12.8	26.4	35.4
Computer sciences	21.1	15.2	34.3	46.4
Mathematical sciences	12.5	10.2	15.4	31.1
Physical sciences	15.8	11.2	17.2	29.3
Chemistry	19.3	14.9	24.8	29.7
Geosciences	7.9	5.3	9.8	19.1
Physics and astronomy	18.2	9.8	18.9	32.5
Other	10.4	9.8	8.4	36.1
Social sciences	7.5	6.7	10.0	12.9
Economics	13.5	11.2	25.8	25.9
Political science	7.2	6.3	11.9	15.2
Psychology	6.2	6.1	6.4	7.6
Sociology and anthropology	6.1	5.3	12.4	12.7
Other	7.8	6.4	10.8	21.6

SOURCE: National Science Foundation, Division of Science Resources Statistics (NSF/SRS), Scientists and Engineers Statistical Data System (SESTAT), 1999

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those born in the former East Germany). By region, 57 percent came from Asia (including the Western Asia sections of the Middle East), 24 percent came from Europe, 13 percent came from Central and South America, 6 percent came from Canada and Oceania, and 4 percent came from Africa.

The 1999 data (which are the most recent) on Immigration and Naturalization Service (INS) counts of permanent visas issued to immigrants in S&E show a small decrease in permanent visas for each S&E occupation. (See figure 3-22.) However, the total number of immigrants employed in S&E is somewhat higher than that before 1992—a year in which various legislative and administrative changes took effect. See sidebars, "High-Skill Migration to Japan" and "Foreign Scientists and Engineers on Temporary Work Visas."

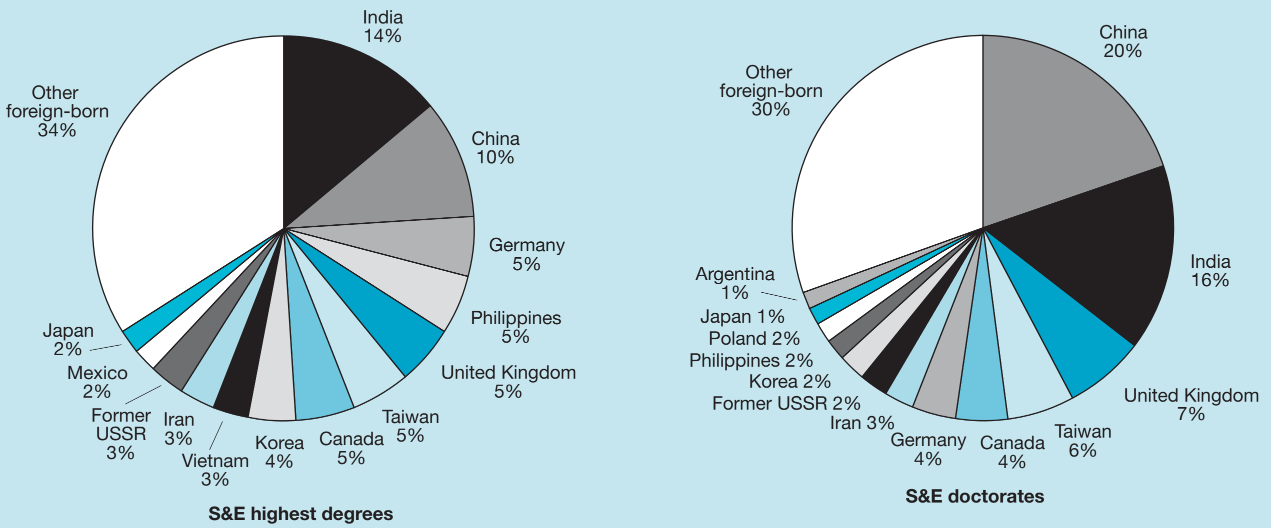
The quantity of permanent visas issued in recent years has been greatly affected by both immigration legislation and administrative changes at INS. The 1990 Immigration Act led to increases in the number of employment-based visas available, beginning in 1992. The 1992 Chinese Student Protection Act enabled Chinese nationals in the United States on student or other temporary visas to acquire permanent resident visas. These changes have allowed more scientists and engineers to obtain permanent visas.[24]

Stay Rates for U. S. Ph.D. Recipients With Temporary Visas

How many foreign students who receive S&E Ph.D.s from U.S. schools remain in the United States? According to a report by Michael Finn (2001) of the Oak Ridge Institute for Science and Education, 51 percent of 1994–95 U.S. S&E doctorate recipients with temporary visas were still in the United States in 1999. The actual numbers of foreign students staying after obtaining their Ph.D.s imply that approximately 3,500 foreign students remained from each annual cohort of new S&E doctorates in all fields. By field, the percentages ranged from 26 percent in economics to 63 percent in computer sciences. (See text table 3-27.) Within each discipline, the stay rate was mostly stable for the 1994–95 graduation cohort between 1996 and 1999. Quite possibly, however, some of this stability came from individuals in this cohort who reentered the United States and thus replaced others who left. Finn also finds an increase

[24]In addition, the easier availability of occupation-based permanent visas affects our measurements: many scientists enter on family-based visas, for which reporting of occupation is optional. If more of these individuals were using occupational visas, the number of foreign-born individuals identified as having S&E occupations would be greater.

Figure 3-21.
Foreign-born with S&E highest degrees by place of birth: 1999



SOURCE: NSF/SRS 1999 Scientists and Engineers Statistical Data System file.

See appendix table 3-51 and 3-52.

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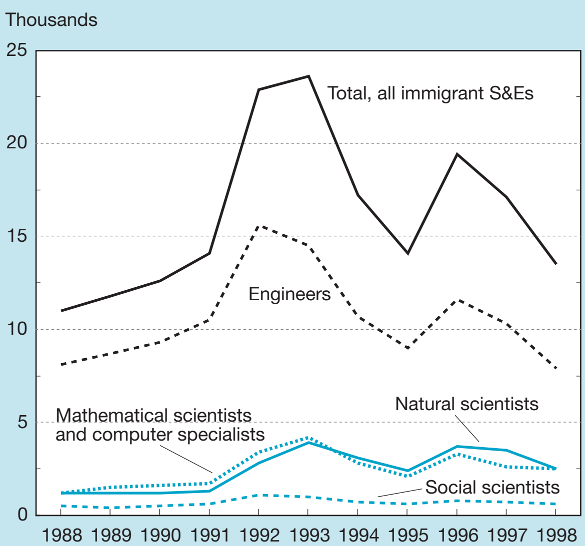
Figure 3-22.
Immigration and naturalization service counts of permanent visas to S&E occupations: 1988–98



SOURCE: Immigration and Naturalization Service Administration Records.

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over time in the shorter one-to-two-year stay rate of temporary visa S&E doctorate recipients from 40 percent in 1989 to 63 percent in 1999. This increase in the short-term stay rate may reflect increased opportunities for postdocs in the U.S. as well as an increased ability of industry to hire high-skilled workers on temporary visas.

Conclusion and Summary

The U.S. S&E labor market continues to grow both in absolute numbers and in its percentage of the total labor market. Even without the dramatic growth of IT jobs, other areas of S&E employment have had strong growth over the past two decades.

In general, labor market conditions for those with S&E degrees, although always better than for college graduates as a whole, have improved during the 1990s. Labor market conditions for new Ph.D. recipients have also been good by most conventional measures—S&E doctorate-holders are employed and doing work relevant to their training—but the gains have come in the nonacademic sectors (i.e., in most fields, a smaller percentage of recent Ph.D. recipients are obtaining tenure-track positions).

The age structure of the U.S. S&E labor force is likely to produce several major changes in the S&E labor market over the next decade. The number of individuals with S&E degrees reaching traditional retirement ages is expected to triple. Despite this, if S&E degree production remains at current rates, the number of S&E-trained individuals in the labor market will likely continue to grow for some time, albeit at a lower rate, as the number of new graduates continues to exceed the number of retirees.

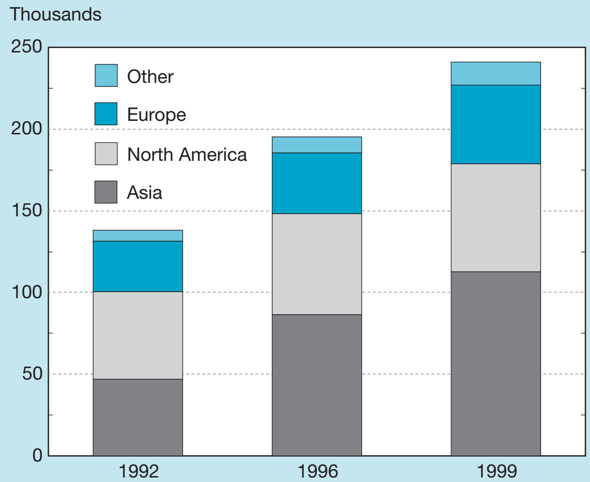
The globalization of the S&E labor force is expanding in two ways: location of S&E employment is becoming more internationally diverse, and S&E workers are becoming more internationally mobile. Although both trends are highlighted by the high-profile international competition for IT workers, every field of science and technology has been affected.

High-Skill Migration to Japan

Visa programs for temporary high-skilled workers have been a focus of recent political debate and legislative change in the United States, Germany, Canada, and many other developed countries. A 1989 revision of Japanese immigration laws made it easier for high-skilled workers to enter Japan with "temporary" visas, which allowed employment and residence for an indefinite period (although the same visa classes are used for work visits that may last for only a few months).

Scott Fuess (Fuess 2001) of the University of Nebraska (Lincoln) and the Institute for the Study of Labor (Bonn) has examined 12 Japanese temporary visa occupation categories associated with high-skilled workers and has written about the growing importance and acceptance of this labor source in Japan. In 1999, 240,936 workers entered Japan in high-skill visa categories—a 75 percent increase since 1992. (See figure 3-23.) For comparison, this is 40 percent of the number of Japanese university graduates entering the labor force each year and nearly double the number of entries to the United States in roughly similar categories (H-1b, L-1, TN, O-1, O-2).

Figure 3-23.
High-skilled worker visas in Japan, entries



SOURCE: Adapted from S. Fuess Jr., *Highly Skilled Workers and Japan: Is There International Mobility?*, University of Nebraska (Lincoln) and Institute for the Study of Labor (Bonn), 2001.

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Foreign Scientists and Engineers on Temporary Work Visas

The use of various forms of temporary work visas by foreign-born scientists has been a subject of policy discussion in recent years. Many newspaper and magazine stories have been written on legislation that temporarily increased the 65,000 annual quota for the H-1b visa program, which provides visas for up to six years for individuals to work in occupations requiring at least a bachelor's degree (or to work as fashion models). Although often thought to be for information technology workers, H-1b visas are used to hire a wide variety of skilled workers.

An H-1b visa is sometimes used to fill a position not considered temporary, for a company may view an H-1b visa as the only way to employ workers waiting long periods for a permanent visa. Because applications for H-1b visas are filed by companies for positions rather than for particular individuals, these applications greatly outnumber the visas actually issued and even the applications by individuals for those visas.

Occupational information on H-1b admissions has not been released, but data are available on the occupations for which companies have been given permission to hire H-1b visa holders. (See text table 3-25.) More than one-half (53.5 percent) of H-1b certifications were for computer-related or electrical engineering positions. Another 4.1 percent were for medical occupations, primarily various types of therapists and technicians but also including medical researchers. Other science and engineering fields garnered 19.7 percent of the certifications; education (including professors) received 5.3 percent, and all other occupations totaled 18.9 percent of 1999 H-1b certifications.

Text table 3-25.
October 1999 to February 2000 S&E-related occupations on approved H-1b petitions

Occupation	Occupations	
	Number	Percentage of total petitions
Total	81,262	100.0
Computer related	42,563	53.5
Engineering and architecture	10,385	13.1
Education	4,419	5.3
Medical	3,246	4.1
Social sciences	1,963	2.5
Life sciences	1,843	2.3
Mathematical and physical sciences	1,453	1.8
Non–S&E-related occupations	15,390	18.9

SOURCE: Immigration and Naturalization Service administrative data.

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Scientists and engineers may also receive temporary work visas through intracompany transfer visas (L-1 visas), high-skilled worker visas under the North American Free Trade Agreement (TN-1 visas, a program primarily for Canadians now but granting full access for Mexican professionals by 2004), work visas for individuals with outstanding abilities (O-1 visas), and several smaller programs. In addition, there are temporary visas used by researchers, who may also be students (F-1 and J-1 visas), or postdocs and visiting scientists (mostly J-1 visas but often H-1b visas or other categories). Counts of visas issued for each of these categories are shown in text table 3-26. The annual quota of H-1b visas is controlled through issuance of visas to workers rather than through applications from companies. Anecdotally, some firms that expect to hire multiple workers on H-1b visas seek permission for many positions, and this affects the distribution of occupations outlined in text table 3-25.

Text table 3-26.
FY 1996 temporary visas issued in major categories likely to include scientists and engineers

Category	Issued
Work visa	
H-1b (specialty occupations requiring bachelor's equivalent)	58,327
L-1 (intracompany transfers)	32,098
TN (NAFTA visa for professionals)	29,252
O-1 (people of extraordinary ability)	2,765
O-2 (workers assisting O-1)	1,594
Student/exchange visa	
F-1 (students)	241,003
J-1 (exchange visitors)	171,164

SOURCE: Immigration and Naturalization Service administrative data.

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Text table 3-27.
Recipients of 1992–93 doctorates with temporary visas at time of degree who remained in United States: 1994–97

S&E field	Temporary residents	Percent in U.S. in: 1994	1995	1996	1997
Total	16,391	48	51	52	53
Physical sciences and mathematics	4,821	55	59	60	61
Life sciences	3,765	48	51	53	54
Social sciences	2,278	29	31	32	32
Engineering	5,527	49	53	53	54

SOURCE: M. Finn, *Stay Rates of Foreign Doctorate Recipients from U.S. Universities* (Oak Ridge, TN: Oak Ridge Institute for Science and Engineering, 2000).

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